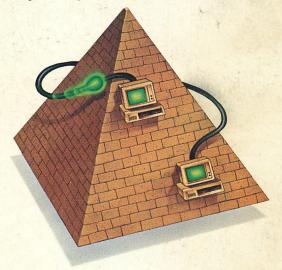
FOR IBM PERSONAL COMPUTER USERS

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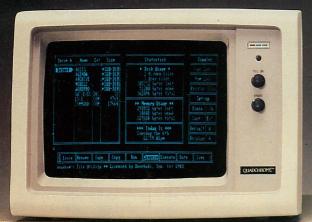


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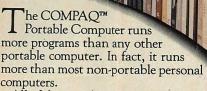


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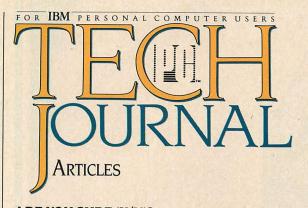


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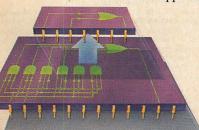


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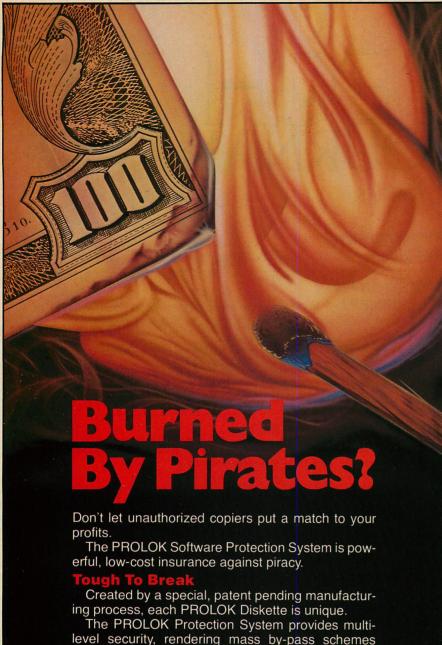
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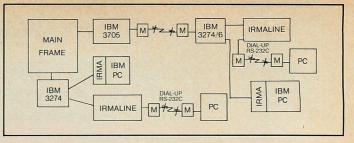
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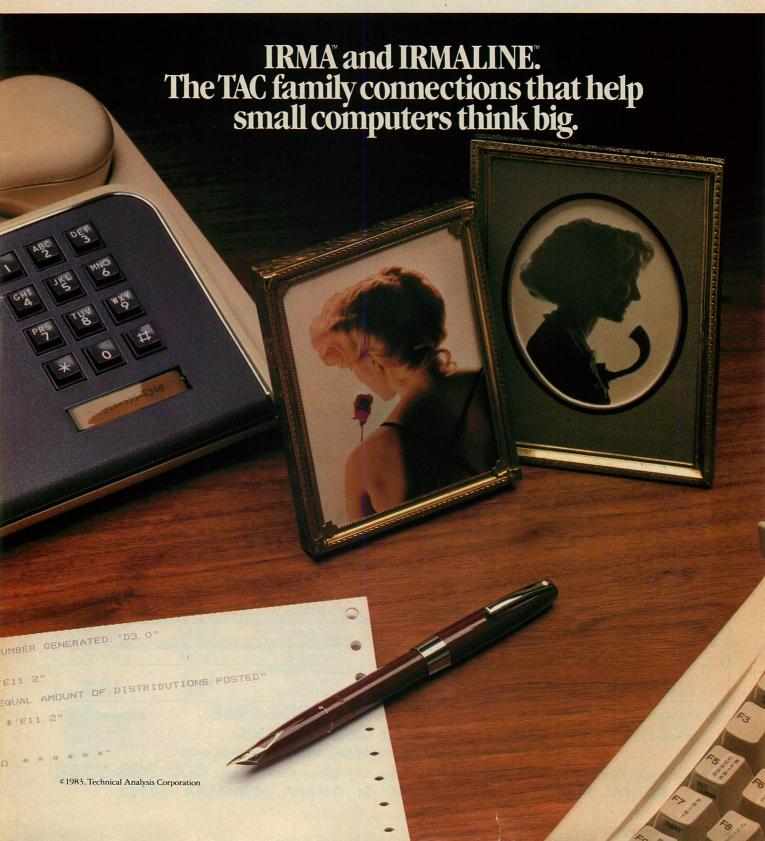
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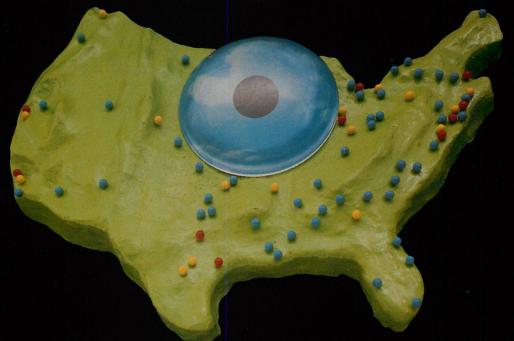
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# Database Programs Are Complex

A search for simplicity fails

#### WILL FASTIE

I have an unfortunate tendency to think that everything, most particularly computer software, should be simple. Needless to say, I get a lot of frustration out of life.

For office purposes, and for my own, I have been looking into information-management software. (Notice my use of the term *information management* and not *database*. A database is a file of information, a data or information manager the software that allows us to get at it.) The search has been interesting and I have learned quite a bit, but I have

not achieved the goal of finding software that would allow me to set up the data files we need and then access them in all the different ways we require. This search now has a new goal: to find software that will accomplish the above tasks, even if programming is required. Ugh.

There seem to be three kinds of information-management products on the market. On the one hand, there are quite a few simple file managers in the genre of PFS:File, Fast Facts, Alpha's Data Base Manager, and even the user-supported product PC-File, in the price range \$35 to \$300. These products share a great simplicity of use and a corresponding simplicity in

the kinds of problems to which they can be applied. The more obvious applications are mailing lists, telephone directories, and other rigidly structured, straightforward data files. PFS:File and Fast Facts add a dimension of flexibility because they are what I call "notebook" systems: they can record variable-length data in free form. Jotting notes about a sales call is easy with a notebook system.

The second kind of information manager is a file system designed to be integrated with a program being developed. Btrieve (for C, BASIC, Pascal and others) and Index + (for Forth) are such products. These products do nothing right out of the box

#### Directions

and do not provide an interactive query facility. However, they usually have the advantage of higher performance, depending on the application.

The third class of information manager is the full-scale system. Most of these products are relational, have a rich and often complicated interactive query facility, include an extended query facility for noninteractive procedures (programs), and may include other subsystems, such as spreadsheet. They usually cost about \$500. In most cases, the extended query languages are as powerful as conventional high-level languages, although they cannot match the latter's performance. Products in this category include Knowledge-Man, MicroRim's R.Base 4000, Condor, dBASE II, DB Master, Optimum, and Fox Research's 10-Base, to name only a few.

A fourth class of product is emerging which claims to combine the power of the third class with the simplicity of the first class. Since we have seen none of these, we cannot comment on them. The demonstrations have been very interesting and sometimes impressive.

What my search has revealed is that my applications are beyond the capabilities of the first class of systems. In particular, I want to deal with more than one file (data type) at the same time and to print five or six different reports in different formats with a considerable amount of calculated data. That means, unfortunately, that some kind of programming is required. And here the real complexity creeps in.

Most of the \$500 packages have an extended query language that allows canned procedures to be executed. A close look at the extensions reveals conventional programming language constructs like if-then-else, while, case, and subroutines. Variables can be defined and used as freely as the names of data items from the file. Screen and printer-forms management is often provided.

I'm a programmer, so in theory

this should pose no great problem. But I don't want to program. It's one thing to spend a few hours setting up a couple of screen layouts and defining some report formats. It's quite another to sit for several days (weeks? months???) laving out the same information, but in excruciating detail, with one of the conventional programming languages. In my desire not to program I think I am more like the typical user, who would find programming difficult and tedious (because it is, of course).

There is a way to tell whether your application requires a more powerful data manager with programming facilities. First, determine if the application is purely interactive, requiring only manual updates and changes to the file, or if it is transactional, meaning that a change to one item mandates an automatic change to another (e.g., posting a sale involves reducing inventory, updating accounts receivable, and maybe generating an invoice or statement). Interactive applications can almost always be built without programming; transactional ones require programming. Second, determine the reporting requirements of the application. Most built-in report generators are not up to complicated reports, so programming will be required here as well. Finally, your application may require the import or export of data from and to other sources. If so, you may again find the built-in facilities inadequate to the task.

So if the problem is just a wee bit complicated, the solution becomes very complicated. What makes this frustrating is that most of us could state an approach to solving most information management problems in less than five minutes, using English.

Too bad computers don't speak English. Yet.

Information management is probably the most important issue in computing today. Local area networks have a lot of sex appeal right now and are certainly important for the long haul, but they will be artifacts unless the problems of data management are dealt with properly. Data-management systems for the PC are in their infancy: network data management is just emerging, and slowly at that.

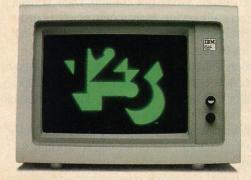
PC TECH IOURNAL, as I hope you are aware, has already begun its coverage of local area networks. In fact, this issue includes Bruce Churchill's overview of Nestar's PLAN 4000 system. Soon, we'll also begin regular coverage of information management with articles on general topics, to be followed quickly by indepth reviews of data-management products, including software, network software, mass-storage devices, and backup equipment. And we'll deliver the same exacting, detailed coverage of these products you have already come to expect from PC TECH JOURNAL.

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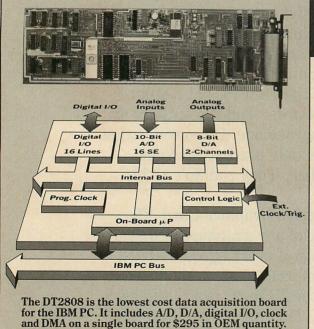
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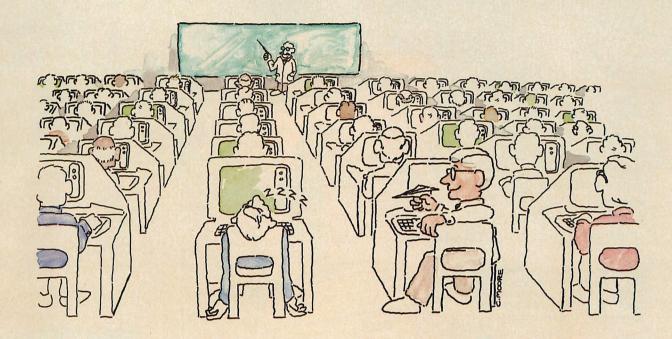
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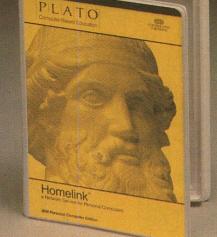




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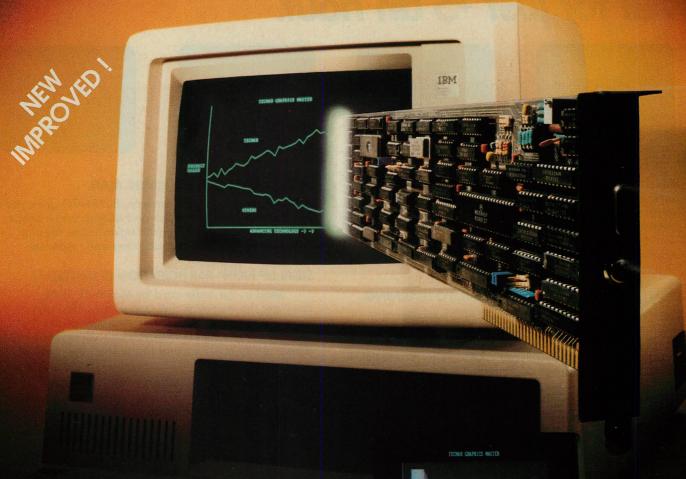
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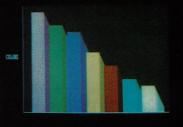
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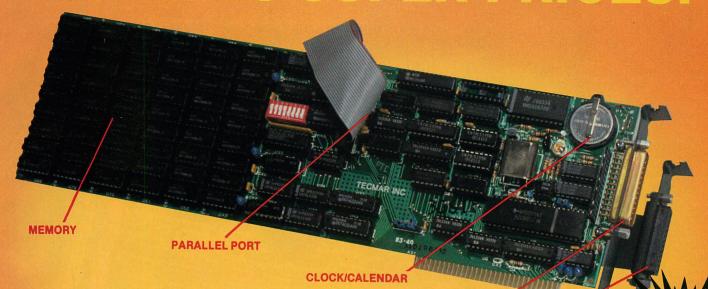
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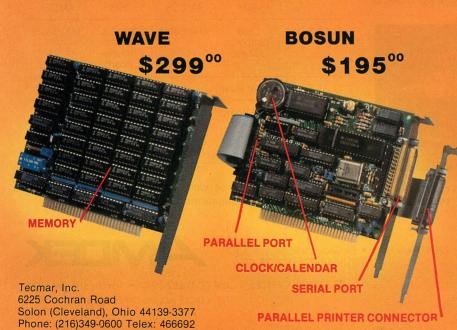
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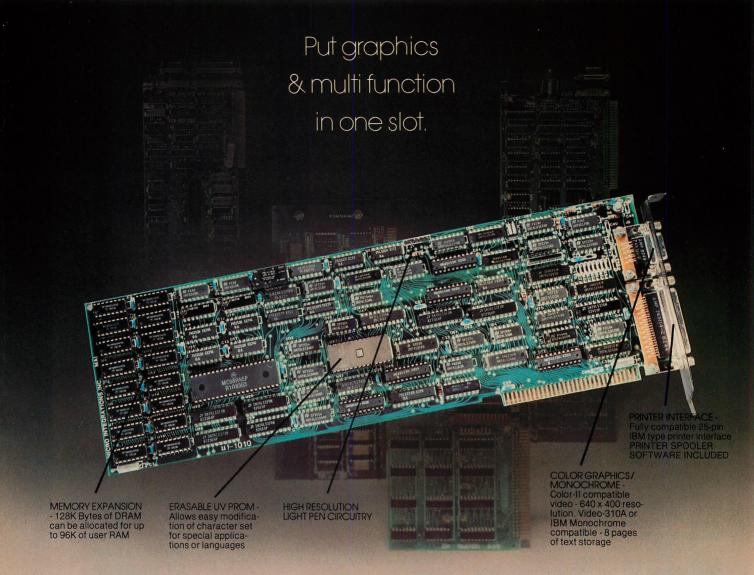
The following features are the same as Captain RAMSpooler Software described above:

- - Autotime<sup>TM</sup> Software
  - PAL Option
  - Cable and Connector

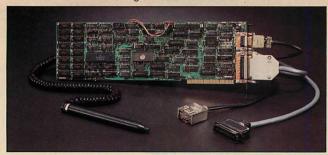
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## Letters to the Editor

#### TECHNICAL TECH JOURNAL

I strongly disagree with the view of Ama Razzak (Nov/Dec) that PC TECH JOURNAL is too technical in using hexadecimal notation in articles. Such detail is of critical importance to properly programming the PC. Indeed, more specific address information is needed, I believe. After all, there should be some place for technically useful information to be published. Perhaps an article on fully utilizing the 8088 segment registers would be appropriate. But, if readers want to learn the fundamentals of assembly language programming, they should go elsewhere.

> Michael Linley Champaign, IL

I am a new owner of an IBM PC with minimal (and I mean it) understanding of computer jargon. All I have had is a one-semester course in management information systems in an MBA program where I learned to sign on to a mainframe computer and write simple programs in Fortran for business application - things like inventory and payments due. When I brought my PC home, a friend of mine who is a computer buff brought over three magazines to look at-yours, PC, and PC World. Now, a week later I can understand about 1/20th of the words in them, but I can appreciate the usefulness of your magazine-its very specific, nuts and bolts approach and its format. What I am asking you to continue is your simple, understandable language approach and clear page notation those nice, big numbers on the bottom outside corners that allow the reader to find the rest of the article in your magazine.

> Joan Bond Sax Brookline, MA

#### WHERE WERE WE?

When I read Will Fastie's article, "Where Am I?" (Sept/Oct), I remembered my UNIX days and thought it strange that DOS didn't provide the "pwd" (Print Working Directory) command.

Taking the massive DOS 2.0 manual in hand, I paged through the "extended" function calls and, lo and behold, I found function call 47, Get Current Directory. Like the other extended, UNIX-like function calls, it was a breeze to use. Fifteen minutes later, I had the pwd command for DOS 2.0. It follows below.

Mr. Fastie's method works, but for me at least, it destroys the pristine quality of the A> prompt. With pwd, we can tell DOS, "Don't call us, we'll call you."

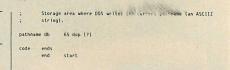
Bruce Kvam Roseville, MN

```
page 60.132
title PMO.ASM
; title PMO.ASM
; title PMO.ASM
; pMO -- Print Vorking Directory. This program prints the pathname
; of the current directory under PCDDS 2.0.
; Author: Bruce Kvam
; To assemble this program do:
; masm pwd;
; link pwd;
; link pwd;
; exeZbin pwd.exe pwd.com
; The ffles pwd.obj and pwd.exe will be left around and should be erased PMO.COM will contain this program.
dos macro function ;; Perform a DOS function call.
mov ah, function
int 21h
mov di, har
dos 2
endm

code segment
assume cs:code, ds:code, es:code
org 100h
start:
; First get and print the current drive.
dos 15h ; get default drive code from DOS,
add al.'A'
putc al
putc ''
; Then get and print the current pathname.
mov dl,0 ; default drive
lea si,pathname
dos 47h ; request pathname from DOS.

printloop:
cmp byte ptr [si],0 ; pathname terminated by 0.
j.; exit
putc [si]
inc printloop

exit:
```



#### **FUJITSU-IBM**

We have been using the IBM PC in Japan for office automation. Our mainframe is Fujitsu (FACOM M150F), and we are looking for communications software/hardware between it and the PC. If you have any information about this matter, please contact and advise us.

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Data Processing Systems
Dodwell & Co., Ltd.
C.P.O. Box 297 Tokyo

#### MATTERS OF PERFORMANCE

Regarding Will Fastie's article, "On the matter of performance," (Sept/Oct) I feel compelled to write a note of agreement. This is the first copy of *PC Tech Journal* that I've read, and, if this article is any indication, I immediately get the impression that this may be the first PC publication that has its feet on the ground.

Coming from a Z80 background, I see very few improvements in the PC (other than RAM). I work with microcomputers (all IBM) within a business environment and it's obvious that 99 percent of the functions performed by the IBM PC could have been performed just as well by previous 8-bit systems had there been enough interest prior to the PC. In fact, from a control standpoint, some of the previous operating systems were far better. The barebones PC-DOS/MS-DOS certainly leaves much to be desired.

It's just a matter of time until the bulk of the PC users become educated to just what the PC and the

# HOWTO GETANIBATE PG S 1995.



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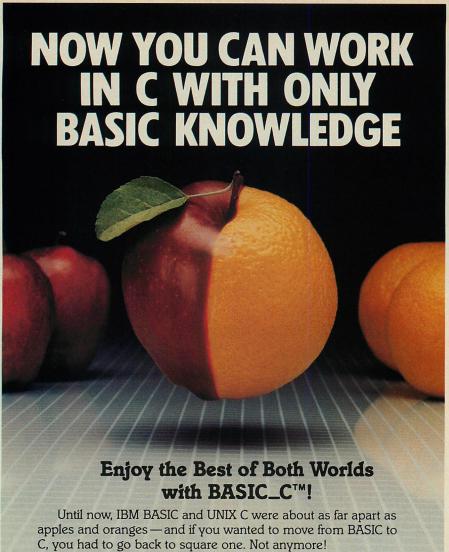
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#### LETTERS

software available for it can and can't do. There's still a lot of interest in bigger and faster. The problem is that few users know how to look. When they learn that, then what they see will be what they get. Will Fastie's article certainly is aimed in the right direction!

Bert Sirkin Enfield, CT

#### FORTRAN PITFALLS

In "FORTRAN Pitfalls" (Sept/Oct) authors Press, Runchal, and Tam misstate the case for the character data type of FORTRAN-77. While as an experienced FORTRAN programmer I can sympathize with their conversion problems, I cannot reach their conclusion that the absence of support for Hollerith data is a deficiency in the language.

Portability is the ability to run a program written in a given language (e.g., FORTRAN-77) under different compilers (of the same language) and on different machines. What the authors want is not portability but upward-compatibility between two languages. Unfortunately, the Hollerith data type is machine-dependent and is a serious obstacle to writing portable programs in FORTRAN-66. The character data type was designed specifically to avoid machine-dependence and enhance portability, not merely to keep up with trends in language design. All of the restrictions on the usage of character data mentioned by the authors, with the exception of comparison of strings of unequal length, are required by the standard to serve this end.

The FORTRAN-77 standard is now six years old. It is time for FORTRAN programmers to bite the bullet on this issue and learn to write portable programs.

Gary A. Hill St. Paul, MN

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# THE TECH JOURNAL NEWSLINE

#### IBM DROPS 4" DRIVE

IBM, after trying unsuccessfully for nearly a year to interest OEM customers in their 4" floppy disk drive, has given up. The device was too nonstandard, too large, too slow, and too expensive compared to the current 5.25" and 3.5" drives. When Boca Raton rejected the drive for its home computer, IBM knew the device was not going to fly and decided to scrap it. The 3.5" drive now appears to be the preferred device in the micro-floppy battle; Sony, Tandon, and Shugart all make drives of that size. There is little doubt that IBM will go to the 3.5" drive in the near future for its home system.

1.71 million shares of Intel stock, which brings its interest in Intel to 15.2 percent. The company started with 12.5 percent and boosted it to 13.7 percent before its latest purchase. Most of the shares were bought in blocks of 40,000 to 60,000. Under an agreement between the two companies, IBM can purchase no more than a 30 percent interest in Intel.

On the subject of stakes, it should be noted that IBM also boosted its equity position in Rolm Corp., which makes sophisticated PBX systems, from 15 percent to 17.7 percent. This apparently indicates IBM's intention to start actively competing with AT&T in this lucrative market. Why not? After all, isn't

of IBM's decision to drop the

4" floppy, IBM intends to

buy into a disk maker such

as Seagate or Tandon. One

is why hasn't IBM bought

into Microsoft?

question that comes to mind

News, views, and gossip on the IBM and IBM-like marketplace

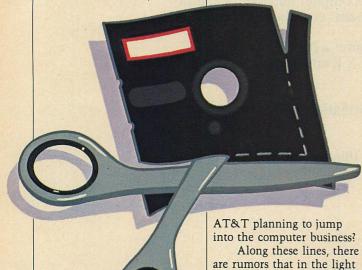


#### **PREDICTIONS**

Egil Juliussen of Future Computing, a market research firm, predicts that by the end of this year IBM will have 18 percent of the \$2.9-billion home computer market, and by 1988 it will have 45 percent of the \$5.9billion home market. He said that distribution through mass merchandisers is required and that 10,000-plus locations are needed to be a leader in the home market. Also, a strong TV ad campaign and "hit" entertainment and educational software packages are required.

#### CAN AT&T COMPETE WITH IBM?

AT&T is expected to introduce its personal computer soon. This machine, which will compete head-on with IBM, is expected to employ a 32-bit micro and to run Unix with an emulator that will allow users to run MS-DOS software. According to International Resource Development of Norwalk, Connecticut, a market research outfit. the software is being developed by Microsoft. The system is expected to be significantly more powerful than the XT. IBM is expected to respond with price reductions on the XT and later with the introduction of a more powerful desktop based on either the 80286 or 80386 Intel 32-bit model.



#### INTEL

IBM went out into the stock market and bought another

IBM BOOSTS STAKE IN

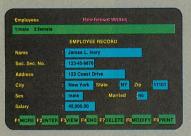
PC TECH JOURNAL



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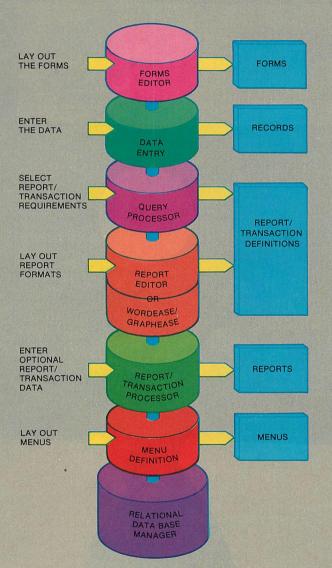
#### **System Features:**

- A list of users can be kept, with passwords and security levels.
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- Data can be interchanged with mainframe computers, other data bases or spreadsheet programs.
- Data base back-up and restore functions are integrated to reduce errors.

#### **System Requirements:**

- Available on the IBM-PC, DEC Rainbow, Wang/TI Professional, Victor 9000, etc. Compatible with MS-DOS and CPM/86.
- Supports floppy or hard disk drives.
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We took the best implementation of AT&T's UNIX operating system designed especially for the IBM personal computer – *VENIX/86.*™ Then we created an elegant but simple menu interface tool to make it more user friendly. And, finally, we selected topnotch applications for decision sup-

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VENIX/86 is from VenturCom, the leading UNIX software development company, which pioneered UNIX for microcomputers. They tailored UNIX for the IBM PC to optimize memory usage, speed, and system reliability. The standard distribution includes: four editors, a C compiler, BASIC, an assembler, yacc and lex. Plus UNIX to UNIX system communications (UUCP and CU), document preparation (nroff), a spelling checker, a table formatter, a wide range of library routines, and more. VenturCom even remembered the UNIX aficionado by including the UC Berkeley enhancements vi, termcap, more and the c shell. Electronic mail, calendar and reminder functions are, of course, standard. The hard disk can be partitioned to permit both UNIX and PC-DOS files. So look no further. VENIX/86 is a complete and faithful UNIX implementation.

#### **New for UNIX Users!**

To make *The Office UNIX System* easy to use, add our new *Office Menu Tool.*™ It allows you to choose from a set of prepared menus or you can make your own. Menus can be constructed

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You bet! For word processing, add the highly acclaimed *The FinalWord*<sup>™</sup> from Mark of the Unicorn. *Viewcomp*, from Unicorp Software, gives you all the features you expect in an electronic

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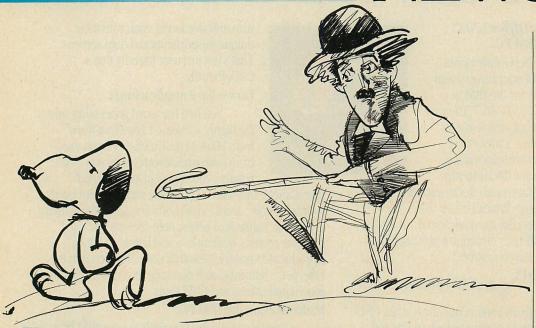
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# MIKE TROSSMAN

## THE TECH JOURNAL NEWSLINE



RANDOM RUMORS
There is a rumor that
IBM tried to get Snoopy, the lovable dog from the
"Peanuts" comic strip, to use
in its advertising of the new
IBM home computer but was
unable to work out an agreement. Oh well, there are still
the muppets!

This year IBM is expected to produce 500,000 home computers and to spend \$75 million on initial advertising to launch the product. IBM has reportedly ordered about a thousand 16032 chips from National Semiconductor for evaluation. The 16032 is National's new 32bit microprocessor, which they expect to start sampling January 1. IBM's interest indicates that it is wide open on which 32-bit micro it plans to use. Besides, the Intel 80386 samples are not expected for six months yet. National claims the 16032 has the power of a VAX.

Sources report that Microsoft is developing a networking version of MS-DOS, to be called—you

guessed it-"MS-Net." The XT is doing much better than IBM had expected; industry pundits estimate that IBM will need 1.8 million 10-Mbyte drives this year, and most of them will be used in the XT. If this is true, Seagate Technology, MiniScribe, and IMI are going to make a mint. According to Business Week, "IBM has already ordered enough components to build 2 million computers" this year. Daniel H. Wilke, an IBM PC manufacturing engineer, says that "a computer is made every 45 seconds." Expected this year are PC clones from Epson, Fujitsu, Sony, Hitachi, and NEC.

Sources report that IBM has delayed introduction of its local area networking system because of problems with the interface chips being furnished by Texas Instruments. Lotus Development, which reportedly sold more than 140,000 copies of its 1-2-3 integrated software package last year, is expected to introduce version two in the late spring. It

will add improved word processing and data base capabilities, communications, and the ability to accommodate user modification. The first IBM PC clone from Taiwan is expected shortly from Multitech Electronics. They are already selling an Apple clone. Expected soon from North Star is a multi-user system that is compatible with the IBM PC and that supports twelve users. There are rumors that IBM is going to start building XT hard disk drives inhouse. Lotus Development Corp. is rumored to be negotiating to buy an as-yetunannounced Picklike operating system for the PC/XT. IBM is supposedly working on versions of the PC/ XT as integrated data/ voice workstations and PBAX peripherals.

Microsoft is soon
expected to announce
its new version of
MSDOS with window
capability. Delivery to
OEMs is expected before the
summer. Digital Research has already an-

nounced that it will add windows to CP/M-86. It is expected that IBM will soon start production of the PC and XT in Australia; there are two plants already in operation in Boca Raton, Florida and Greenock, Scotland.

#### THE BATTLE OF THE OPERATING SYSTEMS

According to John Rowley, president of Digital Research, DR currently has about 900 contracts with OEMs for CP/ M (including both 8-bit and 16-bit systems). Current industry estimates are that Microsoft has about 200 OEM contracts for MS-DOS. Further, DR boasts that CP/M is now running on more than 1.5 million computers throughout the world. Estimates of worldwide numbers of MS-DOS users are less than half this number.

Digital Research is also known to be developing a new version of Concurrent CP/M-86, which will be upgraded to have many of the features of CP/M-80+, including windowing and the ability to run MS-DOS software. In the meantime, version 3.0 of MS-DOS, which Microsoft had promised to start shipping last fall, has been delayed. The new version of MS-DOS is expected to be compatible with Microsoft's XENIX multi-user system and with concurrency (à la Concurrent CP/M-86).

Digital Research has introduced CP/M-80 in a form that integrates the operating system and processor onto one chip. This combined chip is expected to be used by manufacturers of low-cost home computers.

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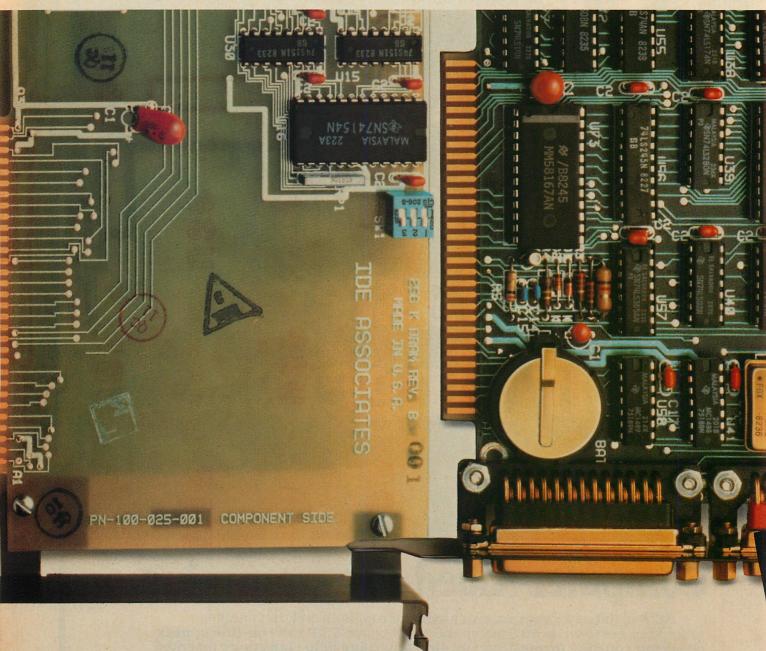
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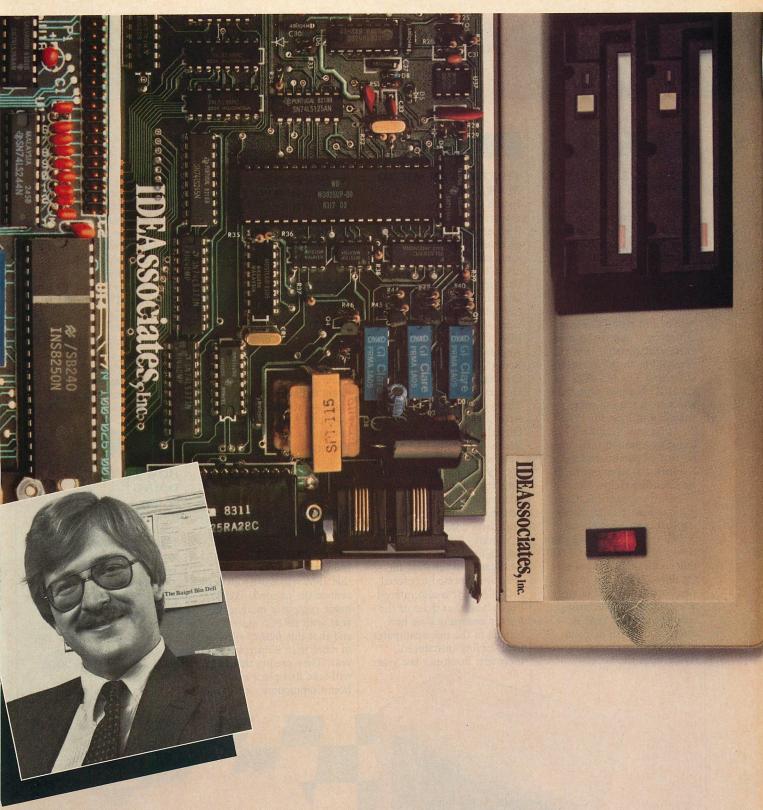
- Randall B. Grossman, Management Analysis Center, Cambridge, MA

When Fortune 500 companies hire you to plan and implement top management strategies, you just don't have room for error. So when Management Analysis Center decided to standardize on add-ons for their IBM PCs, they wanted the most reliable, most integrated line of products they could find. Their choice? Significantly, IDE.

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# THE TECH JOURNAL NEWSLINE

### **COMPAQ & TI SETTLE LAWSUITS**

Compaq Computer Corp. and Texas Instruments Inc. have settled their eighteen-month legal battle, which involved charges of patent infringement, unfair competition, and raiding of employees. The dispute started in 1981 when several TI engineers resigned to create Compaq, which now makes the most successful portable IBM-PCcompatible on the market, outselling TI's MS-DOS machine. Compaq is expected to announced sales of more than \$70 million for 1983.

In a consent decree Compaq admitted infringing on two TI patents and made a substantial payment to TI for licensing rights.

In the meantime, Compaq has gone public, disclosing that it shipped almost 50,000 computers in '83 and is now shipping almost 7,000 units a month. Compaq is considered to be the most successful of the PC clones. We wonder what Compaq will do now that IBM is catching up with demand and lower-cost clones are arriving from the far east.

### THE TOP TEN MICRO MAKERS

Future Computing Inc., a marketing research firm in Richardson TX, has released its chart of the top ten personal computer manufacturers in the U.S. and their anticipated personal computer sales (in millions) for 1983 (including hardware and software). It is as follows:

**IBM** \$1,400 Apple Computer 1,100 Radio Shack 1,100 Commodore 800 Hewlett-Packard 550 Texas Instruments 450 Atari 350 Digital Equipment Corp. 200 Victor 150 Televideo 100

1983 represents the first time that any company has done more than \$1 billion in personal computer sales; last year three companies passed that mark. Total retail sales figures for personal computer hardware and software for 1983 are expected to exceed \$10 billion. It is also interesting to note that three of the top ten companies are newcomers to the microcomputer field, having introduced their first machines last year.

They are DEC, Victor, and Televideo. This year these companies are expected to see even greater success, as it has been estimated that less than 7 percent of U.S. office workers currently have personal computers and less than 10 percent of U.S. homes have a home computer.

### IBM DEMOS LAN

IBM demoed a prototype Local Area Networking system at the Telecom '83 show in Geneva in October. This demo indicates that IBM is close to introducing its longawaited LAN system. The system used a token-passing ring architecture to communicate among word processors, file and printer servers. and PC workstations.

### PCjr's IMPACT

Industry pundits speculate that IBM will corner 20 percent of the under-\$1,000 home computer market this year with its PCjr system, and that this figure will rise to more than 30 percent next year. They predict that IBM will take first place away from Commodore, with Coleco in second place and Commodore pushed down to the number three spot.

Dealers received initial limited shipments of the PCjr in December, but it will be January before any significant quantity becomes available. Predictions are than IBM will produce one million PCjrs this year and probably over three million next year. The low-end unit, which retails for about \$669, costs a dealer about \$480. while the high-end unit, which sells for \$1,269, costs the dealer about \$860.

The question is what will be the impact of this unit on the sales of the PC?

### **HOW IS COMPAO** DOING?

Compaq Computer Corp. is without doubt the most successful of the PC-clone producers. The two-year-old company was a spinoff from Texas Instruments (which is suing for breach of contract and patent infringement). Compaq started shipping its 28-pound portable last January; in its first year, the company expects over \$70 million in revenue from 40,000 units shipped.

Compag has 400 em-





# How you can tell

They're both IBM Personal Computers. And they're the same. Only different.

The system that's on the left is the ideal solution for a person who wants to be creative, efficient and improve his or her personal productivity.

So is the other one.

The system on the left incorporates the quality, the reliability and the technological excellence that have made IBM a computer leader for over 30 years.

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So which is which? Simple.

On the left is the IBM Personal Computer, starting with 64KB of user memory (expandable to 640KB) and

two optional 51/4" diskette drives.

It can easily satisfy your computing needs at the office, at home or in school. With 5 expansion slots,

it gives you room to grow. (You can even make it function like the computer shown on the right by adding an expansion unit that houses one or two 10-million-character fixed disk drives.)

This system can run most of the same software and accept most of the same IBM hardware as the computer on the right. And its price/performance is nothing less than remarkable.

CIRCLE NO. 152 ON READER SERVICE CARD



# THE TECH JOURNAL NEWSLINE

ployees and 400 dealers and hopes to double those figures this year. Their portable was the right product at the right time. Because it provided the highest degree of IBM-PC compatibility in a portable package at a lower price, the company was able to take advantage of the limited supply of machines from IBM to penetrate IBM's own dealer organization. In effect, this machine undercut the market for Osborne portables and therefore led to that company's collapse.

Compaq is known to be working on hard disk and battery powered versions of the machine. However, this segment of the marketplace is expected to become very crowded shortly and hence very price sensitive. The question is whether companies such as Compaq will be able to establish themselves well enough in such a short period to weather the coming storms. Osborne's demise demonstrated how quickly weather conditions can change, driving even the best-launched companies onto the rocks.

# INTEL DELAYS 186 & 286

Intel Corp. is reportedly having trouble delivering the 80186 and 80286 top-of-the-line microprocessors, and this is expected to delay the introduction of the more powerful versions of the PC/XT expected from IBM. Intel has acknowledged that early shipments of these units contained a microcode bug that rendered the units using these chips incompatible with the PC/XT, which uses the 8088 chip.

Intel reports that they have encountered a much higher demand for these parts than they had anticipated. This is expected to cause shortages in the marketplace for some time to come. Advanced Micro Devices, which is expected to be the second source for the chips, is still some time away from production.

Intel is reportedly also encountering problems in

Computer Co., and entered into joint ventures with Mitsubishi Electric and Cosmos 80 Ltd. The three companies will jointly sponsor ventures based on the proposed Information Network System developed by the Japanese government and run by Nippon Telegraph and Telephone



making 286 chips that run above 4Mhz. 6Mhz units are in short supply, and the 8Mhz is scarce. Intel is attempting to ramp up to producing 100,000 286s a month.

# IBM IN JAPAN— JOINT VENTURES

IBM has decided to join rather than fight in Japan. It recently acquired a controlling interest in the Japan Business

Public Corp. The INS system is expected to be fully operational in the year 2000 and will carry digital data and digitized voice and TV over fiber-optic lines. IBM will own 34 percent of the research and development company and 45 percent of the operating company.

# IBM REPORTS RECORD PROFIT INCREASE

IBM reported that net income for the third quarter of 1983 rose 25 percent to \$1.3 billion. According to John Opel, IBM chairman, IBM sold 850,000 PC/XT units in '83 and expects to sell about 2 million this year. Personal computer sales accounted for 2-4 percent of IBM's sales; this year that figure is expected to rise to 6 percent.

Incidentally, IBM's income from interest on bank deposits and securities tripled to \$232 from \$80 a year earlier. In other words, IBM has a lot of cash sitting in the bank and is therefore looking to spend it on increasing its outside holdings in suppliers (for example, Intel).

# IBM DROPS JOSEPH-SON DEVICE PROJECT

IBM has halted all development work on Josephson technology and closed its pilot production plant. IBM had hoped to use Josephson devices in their next generation of high-performance mainframe computers. These superconducting devices promised operating speeds fifty times faster than those of current systems.

The nearly-twenty-yearold project had cost IBM an
estimated \$100 million and
had gotten to the point
where IBM had built prototype cache and RAM memory systems using the devices.
The decision to cut back was
reportedly made because of
the rapid advances in conventional silicon technology
and the problems related to
manufacturing computer systems based on an entirely
new technology.



Contact your local retail computer store for a The Rixon® PC212A offers you the only 300/1200 BPS full duplex card modem with auto dial and auto answer that plugs directly into any of the IBM PC® \* card slots. Because the Rixon PC212A was designed specifically for the IBM PC, it is loaded with user benefits.

The PC212A eliminates the need for an asynchronous communications adapter card and external modem cable, this

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Smartmodem TM \*\* such as CROSSTALK.TM+Also available

for use with the PC212A is the Rixon PC COM I,TM \* a communications software program (Diskette) and instruction manual to enhance the capabilities of the PC212A and the IBM PC. PC COM I operates with or replaces the need for the IBM

Asynchronous Communications Support Program. The program is very user friendly and provides single key stroke control of auto log on to multiple database services (such as The Source SM&), as well as log to printer, log to file transfer and flow control (automatic inband or manual control). PC COM I is only \$49.00 if purchased at the same time as the PC212A. The PC212A comes with a 2 year warranty. For more information contact your nearest computer store or Rixon

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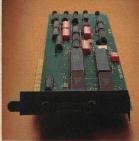
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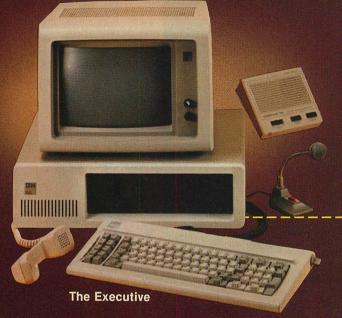
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All versions of ELAN include an Ethernet interface with equipment to convert voice into data and back again. This enables the user to give and receive spoken messages from any location as well as store them for later use. In addition, with the Executive version, all ELAN software packages can be operated through verbal commands, through the telephone keypad or through the IBM PC keyboard. The computer can then respond verbally, either by telephone or 'in person'.

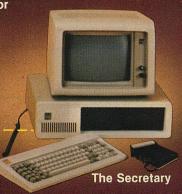
The Manager

The MANAGER system adds a modem for telephone data communications and by adding a separate handset, will permit voice communications. The modem enables the MANAGER to receive unattended voice and data from any telephone in the U.S. Also, the MANAGER can accept commands through decoding the tones from the telephone keypad.

The EXECUTIVE is the most complete implementation of ELAN, adding computer recognition of spoken commands. An executive might phone the PC to leave or retrieve messages or request specific information. The PC, in a spoken voice, can request a user's access code or prompt the user for a command. The executive can respond either by pushing buttons on the telephone, or by actually speaking back to the computer.

The SECRETARY is the basic ELAN system. It includes an Ethernet interface and all other ELAN features except modem and voice recognition.

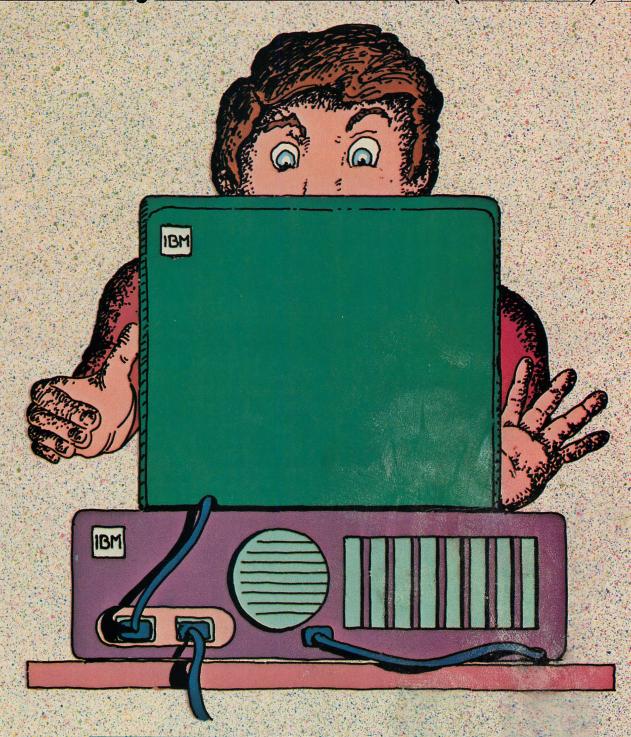
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\*ELAN (Extended Local Area Network) formerly ComNet

TECMAR 6225 Cochran Road, Cleveland, Ohio 44139, Phone (216) 349-0600, Telex 466692

# Are you sure (Y/N)?



An important, useful, and simple-to-use file utility program

JEFF GARBERS

o, really, it's okay
... please sit back down
... breathe deeply and you'll be
fine. In *print*, those words can't hurt
you.

On the screen of your PC, however, they're enough to raise your heart rate a few beats. If you see them, you've just asked to delete all the files on your disk. Your computer, normally quietly obedient and

n an effort to reduce both anxiety and finger work, you might turn to VDEL, a program that allows selective deletion of disk files matching a pattern.

unmerciful, suddenly develops a conscience and gives you a chance to back out. And often you do, trembling fingers pressing N followed by DIRs and TYPEs to make sure you're not destroying anything you need.

Unfortunately, this safety net is provided only when deleting *all* of your files. You have the unenviable opportunity to throw the baby out with the bathwater every time you use DOS's wild card delete, as in

### **DEL \*.BAS**

which would delete all your BASIC programs. Either you take your chances, or you delete each file individually by typing its whole file name—good typing exercise, but you probably have better things to do.

In an effort to reduce both anxiety and finger work, you might turn to VDEL, a program that allows selective deletion of disk files matching a given pattern.

Jeff Garbers works for Userview Corporation in Atlanta, a software research and development firm specializing in human factors.

### WHAT IT DOES

VDEL is a .COM file, a small program that can be called as a command directly from DOS by typing its name. You might type, for example,

### VDEL\*.BAS

to selectively erase the BASIC programs (files with the extension .BAS) from your disk. The whole transaction might look like the example shown in figure 1.

After each file name was presented, you would press Y if you wanted to delete the file (as in the cases of ERNIE.BAS and BIG-BIRD.BAS here), or N if you wanted to leave it alone (as with BERT.BAS). Only the Y or N key alone need be pressed; VDEL itself displays the words Yes and No. If for some reason you wanted to stop everything and get back to DOS, you would press the Esc key. The program is also set up so that the file is spared if you press anything other than Y, N, or Esc.

for some reason you wanted to stop everything and get back to DOS, pressing the Esc key would do that. The program is also set up so that if you press anything other than Y, N, or Esc it is as if you had pressed N—that is, the file is spared.

### **ORIGINS**

VDEL was written on the morning of August 3, 1982 (at least that's the date on the VDEL.ASM file). I was in the early stages of developing Infoscope, and was getting nervous about the prospect of accidentally deleting important source code. Having seen a selective deletion utility on a CP/M

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We have come up with the best value in true letter-quality printers on the market. Take the time to read this ad, and we'll prove it to you.

What's been the persistent dilemma in buying a printer for a personal computer? Top performance letter-quality printers have always been expensive. The lower priced attempts have proved clumsy, noisy, and slo-o-o-w. And don't be fooled by "correspondence quality" claims for matrix printers: there is no way around the fact that they produce characters from dot patterns. Letters and reports just don't look, well, *typed*. If you want fully-formed characters, and a true typewritten look, there is no shortcut. Now comes the perfect combination: a low-cost, truly letter-quality printer, with a housing that makes it look much more costly—and it is even fast! The Juki 6100.

We benchmarked the nearest approximations, the Silver-Reed EXP 550, the Brother HR-1, and the Smith-Corona TP-1. Good products all. But then we put the Juki 6100 through its paces against this checklist:

- 1. Print Quality
- 2. Print Speed
- 3. Noise level
- 4. Reliability
- 5. Warranty
- 6. Versatility
- 7. Physical Specifications
- 8. Ease of Installation & Use
- 9. Price

1. **Print Quality.** This is where it really shines. Our printer uses print wheels and ribbons designed not for computer printers, but for *typewriters*—where the standards for "letter quality" are set. The printwheels are Triumph-Adler style: true typewriter quality, because that's what they were designed for. What's more, the printer uses IBM's Selectric II typewriter cartridges, so enough said about

quality of the ink and the print impression. Chances are you already stock these cartridges in your supplies cabinet.

- 2. Print Speed. Using the standard Shannon test for plain text, we do a true 18 characters per second. That exceeds all three rival printers, and is half again faster that the Smith-Corona. But there is more. The Juki designers put in logic-seeking bi-directional printing and high speed motion over blank spaces. This means that typing speed on typical text is as fast as printers with much faster ratings. And there is a built-in 2,000 character buffer in the printer to free up your computer even before the printing is done.
- **3. Noise level.** Quiet level is more accurate. The technical rating is better than 62 dBA from 1 meter away. If you don't know a dBA from a D&B, it means no raucous clatter to rattle the nerves or jam your phone conversations, a big improvement over some printers we listened to. The other three are two to eight times noisier.
- 4. Reliability. The engineers know what an MTBF of 2500 hours at 25% duty means. More meaningful for most of us: there are very few moving parts. Other printers employ a complex system of electric motors, wires pullies, and springs. Not only do they breakdown, they also go out of adjustment. But the Juki uses a far more elegant design: the printhead glides across a rail by magnetic traction. That's all there is to it. If you look inside, you will see a startling simplicity.
- **5. Warranty.** We give you a full 90 days limited warranty which covers parts and labor, but we don't think you'll be testing this part of our offer. Still, it's nice to know it's there. It means you really cannot go wrong by ordering and putting this printer through its paces.

# and brought home a major discovery!

6. Versatility. The is a virtually unlimited choice of type styles to choose from-over 100 in the catalogue we checked. Our printer can print at 10, 12 and 15 characters per inch and also take Proportional Spaced wheels for that extra touch of class. We also have an economical and reliable bi-directional forms tractor as an option, if you want to handle continuous stationery, or print graphics including the use of reverse-paper motions.

We supply a 100-character Courier 10-pitch (characters per inch) printwheel with the full ASCII character set and extra Word Processing symbols. The other three printers can't match that: Smith-Corona

# 7. Physical Specifications.

18 characters/second Print Speed: Daisywheel: Triumph-Adler compatible

Drops into place

Printing Characters: 100 per wheel

Printed Line Length: 110 characters under 10 pitch

132 characters under 12 pitch 165 characters under 15 pitch

82 to 220 characters under proportional spacing mode

Horizontal Resolution: 1/120 inch minimum

1/48 inch (1/96 inch possible by using escape sequence) Vertical Resolution:

13 inches (Printing line 11 inches) Platen Size:

IBM82 Compatible multi-strike or single strike (Selectric II) Ribbon:

Centronics parallel Interface:

40 W idling, average 80 W printing Power Consumption: Width: 20.5", Depth: 17.9", Height: 5.9" Dimensions:

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15 minutes MTTR:

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Bi-Directional Forms Tractor, \$169.00 Options:

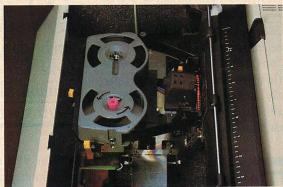
- 8. Ease of Installation and Use. The Juki is fully compatible with your IBM PC or XT. Just plug it into the parallel
- · We don't send you on a search for a cable to make things happen. It's in the box.
- And it's exasperating to be all set to go-but no ribbon. So we give you a ribbon. Loading is clean and simple—it's an IBM Selectric style cartridge, remember.
- We also give you a printwheel: a courier 10 (characters to the inch), the most popular typeface. The fun comes in loading it: just pull back a lever, and drop it in. No cover or ribbon removal, no inky fingers. No figuring out why it doesn't attach. It drops into a recess and the printer engages it entirely on its own!
- And one more thing. In the continental United States, we pay the shipping!
- 9. Price. \$579.00 complete with power cable, computer connection cable, printwheel, and ribbon cartridge, and freight. It's all there! Everything you need to have this handsome printer typing crisp, perfect pages minutes out of the box.

We wouldn't spend two pages if we weren't onto something big. Make the same discovery. Call us right now. Use our 800 number. Or fill in the card and mail. Ask for the following:

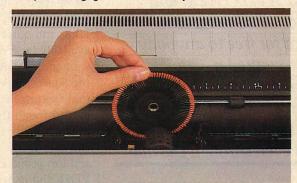
> Product Code Price

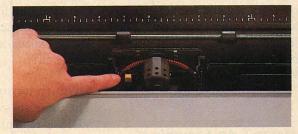
Juki 6100 Printer, with cable: J6100 \$579 \$169 Bi-Directional Forms Tractor (optional): J6150





Above: Easily accessed controls are on the front panel. The printhead, ribbon, and printwheel are mounted as a single mechanism. Below: The printwheel simply drops into place; the printer engages it automatically!



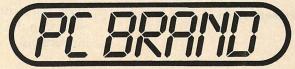


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# ARE YOU SURE?

system, I decided it would be a nice thing to have under PC-DOS.

Because the program was going to be small and simple, I decided right away to write it in assembly language. This would give me the control needed to communicate easily with DOS, and give me the chance to learn how to use the directory-search and file-deletion functions provided by DOS. It also would produce a very compact program. VDEL. COM is 404 bytes long, it loads quickly, and takes up little room on disk (making it particularly attractive for RAM-drive storage). The program ran properly the first time, I added some addition-

oo small to sell all by itself, VDEL (along with LF, CD, SYSTAT, PC-HEX, and other small programs) went for free to anybody who wanted it. Copies went out through the Source, through my own Midnight Express system, and even through the mail.

al error-checking and cosmetic enhancements on the second pass. Total development and testing time was under three hours.

VDEL was also something of an

# Figure 1: An Example of a VDEL Session

A>vdel \*.bas

Press Y to delete, N to skip, ESC to stop.

Delete ERNIE .BAS? Yes Delete BERT .BAS? No Delete BIGBIRD .BAS? Yes

No more matching files.

A

experiment in software portability. Because it required no fancy graphics, screen control, or noisemaking, the program could be written to run under "vanilla" DOS, VDEL uses

otice also that testing programs that delete files can be dangerous. PLEASE make sure that you have no valuable files on-line when playing with VDEL.

DOS for all file control, keyboard input, and display output; as such it has run unmodified on every PC-DOS or MS-DOS system I've tried it on.

Because it was too small to sell all by itself, I decided to make VDEL (along with LF, CD, SYSTAT, PC-HEX, and other small programs) available for free to anybody who wanted it. Copies went out through the Source, through my own Midnight Express dial-up system, and even through the mail. The program began popping up on bulletin boards and user group disks-of-the-month. and I'm proud to say that today VDEL and its friends are in the libraries of hundreds (maybe thousands) of PC users across the United States, Canada, and who knows where else.

### HOW IT WORKS

The complete source code listing for VDEL is reproduced here. Many additional comments have been added to enhance readability, but the program will assemble to the same VDEL. COM, which has been widely distributed. While this article is not intended to serve as an introduction to assembly language programming, the VDEL listing may provide some ideas to get you started. If you want to work with the program, follow these instructions:

- 1. Make sure you have MASM.EXE (the Macro Assembler), LINK.EXE (the Linker), EXE2BIN.COM (a conversion utility), and your favorite editor available. (While LINK.EXE and EXE2BIN. COM come on your DOS diskette, MASM.EXE is a separate product).
- 2. Using your editor, type in the source code as it appears here. Comments (lines beginning with a semicolon) need not be included but will help readability. Put it all in a file called MYVDEL.ASM.
- 3. Assemble the file by giving the DOS command

# MASM MY-VDEL;

4. If there were errors in assembly, go back and fix the problems. If not, link the program by giving the command

# LINK MY-VDEL;

LINK will warn you that no stack segment has been defined; don't worry about it.

5. Convert the program to a .COM file by giving the commands

# EXE2BIN MY-VDEL RENAME MY-VDEL.BIN MY-VDEL.COM

6. Clean up the unneeded files by typing

# DEL MY-VDEL.OBJ DEL MY-VDEL.EXE

If you already have a working VDEL.COM, you may want to use it here.

7. Test the program on some files you don't need any more.

I have used the file name MY-VDEL here so as to avoid destroying the real VDEL.COM, which you may already have on your disk. When you get the program working, change the name as you wish.

Notice also that testing programs that delete files can be dangerous. PLEASE make sure that you have no valuable files online when playing with VDEL.

# LISTING 1 VDEL

```
title VDEL - Verified Deletion Utility (C) 1982 J. P. Garbers
                                                                                       ; Macro SAY prints the message associated with its argument.
comment @
                                                                                              DOS
                                                                                                      PRINT MESSAGE msg name
                                                                                              endm
               .. .. .... ...... ....
               ; Macro SHOW prints out a single char argument to the screen.
               11 11 11 11 1111
                                       **
               SHOW macro arg
                ****
                     mov
                                                                                                      dl, arg
                                                                                              DOS
                                                                                                      PRINT CHAR
                                                                                                                               :print it
                                                                                              andm
                                                                                      ; Macro CLEAR takes a register argument, and sets it to zero ; by xor-ing it with itself.  \\
               Jeffrey P. Garbers
               3 August 1982
Date:
Installation: General PC-DOS / MS-DOS
                                                                                       CLEAR macro
                                                                                                      rea
                                                                                                      reg, reg
                                                                                              xor
                                                                                              endm
Operation:
                                                                                      ; Macro ONERR takes the name of a message as its argument, and
; generates code to get out of the program if AL is OFFH (that is, if
From DOS command level, type
                                                                                      ; an error condition was generated from a DOS call). To effect ; the return, we jump to EXIT, which should be a RET instruction.
       VDEL <filespec>
where <filespec> is a file specification that probably contains wildcards.
                                                                                       ONERR macro
                                                                                                      message_arg
                                                                                                      OKAY
                                                                                              local
                                                                                                      al, ERR
As each matching file name is presented, pressing "Y" or "y" will delete
                                                                                              cmp
the file; pressing "Esc" will stop the program, and pressing "N" (or anything
                                                                                                      OKAY
                                                                                                                               ; nope, skip around this stuff
                                                                                              jnz
                                                                                                                               ; print the error message
                                                                                              SAY
                                                                                                      message arg
                                                                                                      EXIT
                                                                                                                                ; and go away
                                                                                              jmp
else) will leave the file alone and proceed to the next matching file.
                                                                                       OKAY:
                                                                                                                               ; nothing to do... just continue
endcomment @
       page
       subttl Macros and Declarations
                                                                                              subttl Program code and data
: Useful macros and declarations borrowed from the USEFUL development library.
                                                                                       ; Define the code segment, and set things up for a .COM program.
       See program text for examples of use.
                                                                                       CSEG segment para public 'CODE'
                                                                                              assume cs:CSEG, ds:CSEG
 ; Some mnemonic names for DOS function calls.
                                                                                       : Programs which are to be put through EXE2BIN must start at address
                                ; print a single character to the display
 PRINT CHAR
                        02H
               eau
GETKEY NOECHO equ
PRINT MESSAGE equ
                                                                                       ; 100H, so...
                                ; get a keystroke without echoing it
                        08H
                                ; print message terminated with '$' (MARK)
                        09H
                                                                                              org
                                ; search for first directory entry
 SEARCH FIRST
                        11H
                                                                                                                                        ; jump around the data area
                                                                                       START: imp
                                ; keep looking
 SEARCH NEXT
               equ
                                ; delete file
 DELETE FILE
                        13H
               equ
                                set disk transfer address
               eau
                                                                                       ; We'll put the data area and messages near the beginning so they're
 : Some mnemonic names for special character values.
                                                                                       ; LOOKUP FCB is a File Control Block which we use in scanning the directory.
                094
                DAH
 LF
       equ
                ODH
 CR
       equ
                                                                                       LOOKUP FCB
                                                                                                              32 dup(?)
                                                                                                      db
        equ
                1BH
 ESC
 MARK
       equ
                151
                                                                                       ; The program prompts and messages.
 ERR
                DEEH
                                                                                       COPYRT
                                                                                                               'Copr. 1982 J. P. Garbers'
 ; A mnemonic name for a special location.
                                                                                                                       'No matching files.', MARK
                                                                                       NOMATCH
                                                                                                               db
                                                                                       THATSIT
                                                                                                               db
                                                                                                                       CR,LF, 'No more matching files.'
               equ 05CH; location of first argument FCB
 ARGECE
                                                                                                       dh
                                                                                                               CR. LF. MARK
                                                                                                               'Cannot delete file-- disk write-protected?'
                                                                                       NODEL
                                                                                                       db
                                                                                                               CR.LF.MARK
 ; Macro DOS takes one argument-- a DOS function number-- and generates
                                                                                                       db
 ; code to call DOS with that function. If an optional second argument
 ; is present, we move its offset into the DX register.
                                                                                                               CR.LF, 'Press Y to delete, N to skip, ESC to stop.'
                                                                                       INTRO
                                                                                                       db
                                                                                                                CR, LF, LF, MARK
                                                                                                       db
        macro
                fcn code, optional dx arg
                                                                                                               TAB, 'Delete ', MARK
                                                                                       FACH
                                                                                                       db
                ah, fcn code
        mov
                                                                                                                '? ',MARK
                                                                                       TAIL
                                                                                                       db
        ifnb
                <optional dx arg>
                                                                                                                'Yes', CR, LF, MARK
                                                                                       YES
                                                                                                       db
               dx, offset optional dx arg
        mov
                                                                                                                'No', CR, LF, MARK
                                                                                                       db
                                                                                        NO
        endif
                                                                                                               'Stop', CR, LF, MARK
                                                                                       STOP
                                                                                                       db
        int
                                                                                                                       CR, LF, MARK
                                                                                        NEWLINE
        endm
```

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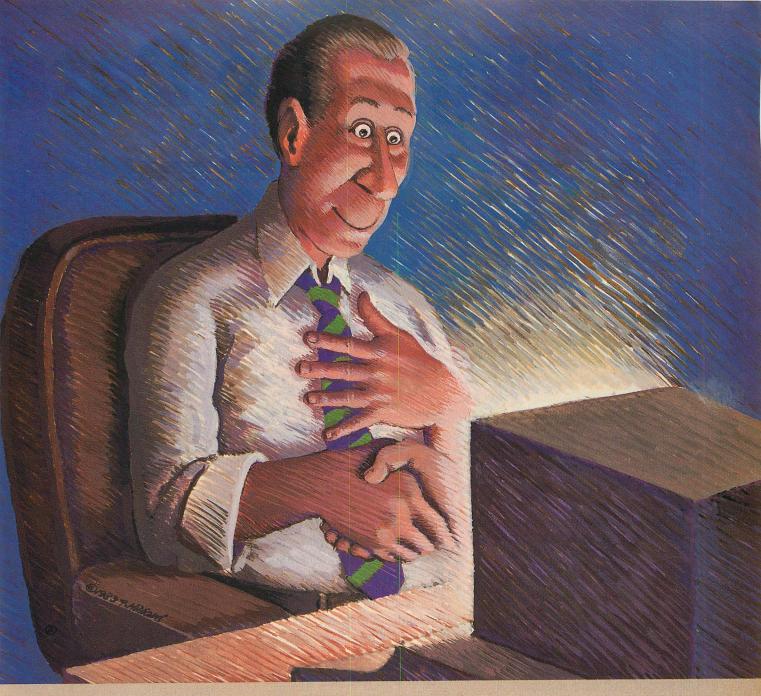


# ARE YOU SURE?

```
; The beginning of the actual program.
MATN
       proc
; First, we must set the stack up so a RETurn instruction gets us back
; to DOS. We do this by pushing the DS register, and then pushing a
  word of zeroes.
       push
              ds
       clear
              ax
                                      ; push the zeroes on the stack
; Since the DOS directory search function call puts the directory entry
; it finds at the current Disk Transfer Address, we need to set the
   DTA to our local File Control Block.
              SETDTA LOOKUP FCB
; Try looking for the first file. We pick up the parameter from ARGFCB,
; which is located at address O5CH. If there aren't matching files, report
; the NOMATCH error, and quit.
              dx, ARGFCB
SEARCH FIRST
       mov
      DOS
       ONERR NOMATCH
                                     ; no files -- leave
; We have at least one match. Display the introduction message.
; CYCLE is the main loop. We print the leadin message for each file
; name, the file name itself, and the prompt message. We then get
  a keystroke, and act accordingly.
                                      : show message
              st, offset LOOKUP_FCB+1 ; point to name
      mov
                                    ; 8 chars to print in name
; The SI register points to the first character in the name. We use
; the LODSB instruction to get the character and point to the
 next one, and we call DOS to print each one as we get it.
CYC1: lodsb
      SHOW
                       ; print it
       1000
              CYC1
; Finished with the name... show the period between the name and extension.
      SHOW
                                     ; period for extension
      mov
              cx. 3
                                      ; prepare to print 3 char extension
CYC2: lodsb
      SHOW
             al
```

```
CYC2
                                      ; show the extension too
                                      ; print out the after-part
; Now we've printed out the file name and prompting message. Get the
; keystroke and see what the user wants to do with this file.
              DOS GETKEY_NOECHO
                                             ; get the keystroke
                                    ; extended ASCII?
              al, 0
                                    ; yep... if so, re-call for input
       jz
              VERIFY
                                      ; to throw away the subsequent code
; Got a keystroke value in AL. Let's see what to do with it.
              al, ESC
              DUIT
                                     ; yep - leave
                                     ; is this a lower case 'y'?
       jz
              KILLIT
                                    ; yep, go kill the file
                                      ; upper case, perhaps?
      jz
              KILLIT
                                     ; yep, kill it too
; We didn't get an Esc, and we didn't get a Y. Leave the file alone,
; and proceed.
      SAY
                                    ; default is negative
      jmp
              NEXT
                                     ; and get the next one
; If we get here, we want to delete the file. Call DOS for service
; to do so. If the DELETE FILE function call returns something besides
; zero, report an error message and continue.
KILLIT:
              SAY
       DOS
              DELETE FILE LOOKUP FCB ; ask DOS to delete the file
       CMD
              a1. 0
                                     ; did it work?
              NEXT
                                      ; yep
              NODEL
                                     ; report inability to delete the file.
: When we get here, it's time to look for another match.
NEXT: DOS
              SEARCH NEXT ARGFCB
                                     : look up next one
                                     ; leave if no more
    ONERR
              THATSIT
                                      ; keep looking
QUIT: SAY
                                     : say goodbye
EXIT: ret
                                     : and split out
MAIN endp
CSEG ends
       end
```





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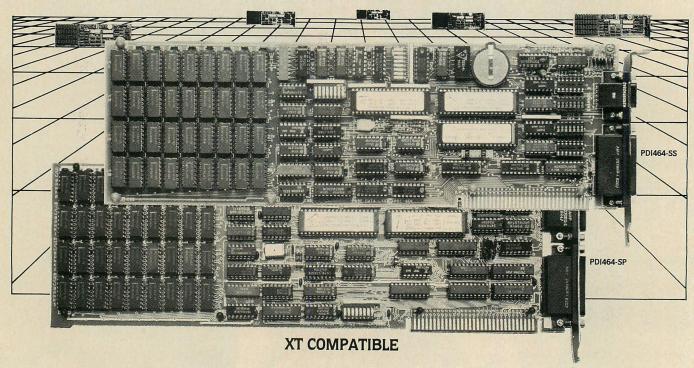
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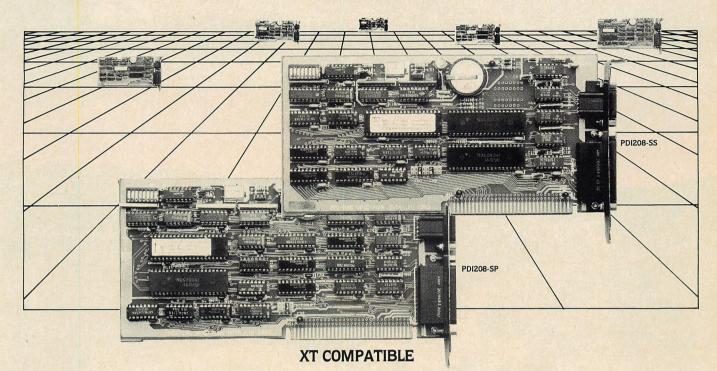
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- Software for clock support, dynamic memory configuration, memory testing
- Only occupies one expansion slot
- Fully-illustrated installation and operation manual

# PDI208-SP

- IBM-compatible serial channel with selectable address and 6-foot cable
- IBM-compatible parallel printer adaptor with selectable address
- Real Time Clock/Calendar with field-replaceable lithium battery backup
- p-Disk<sup>TM</sup> disk emulator for single/double-sided diskette emulation
- Print spoolers for parallel and serial channels with multiple
- Software for clock support, dynamic memory configuration, memory testing
- Only occupies one expansion slot
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# PDI208-SS

- Two IBM-compatible serial channels with selectable addresses. 6-foot cables
- Real Time Clock/Calendar with field-replaceable lithium battery backup
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- Print spoolers for parallel and serial channels with multiple
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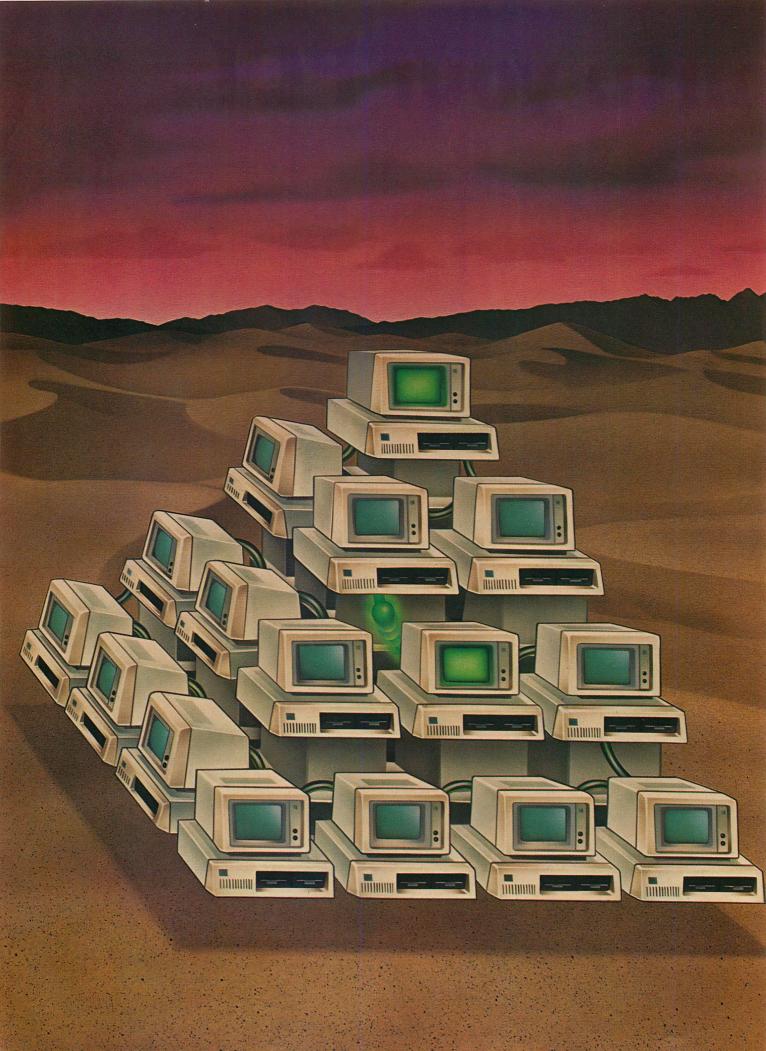
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# AN OVERVIEW OF A TOKEN-PASSING LOCAL AREA NETWORK FOR THE IBM PC

In the previous two articles in this series I discussed local area networks that were based on "contention" access control. These systems used Carrier Sense Multiple Access technology to accommodate a large number of users contending for shared network resources, such as printers and mass storage devices. PLAN 4000 has a somewhat different approach to arbitrating access to the shared devices. You will notice, however, that many aspects common to all local area networks are featured in PLAN 4000, despite the different communications technology employed in this network.

### **OVERVIEW**

PLAN stands for Personal Local Area Network, an appropriate acronym, since PLAN 4000 connects IBM PCs, Apple IIs, and Apple IIIs. PLAN 4000 has a distributed-star physical topology and is classified as a baseband, logical-ring network, with token-passing access control. In the two networks I reviewed previously, PCnet and EtherSeries, the topology was straightforward: they were distributed-bus systems with a single cable and workstation and server taps at prescribed intervals. A distributed-star topology is somewhat more complex to visualize, but at the same time it permits more flexible installations than does a distributed bus. It is important to

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keep in mind the distinction between physical and local topologies: the physical distributed-star topology of PLAN 4000 does not have the inherent disadvantages of a typical star network. This combination of topology and access control gives PLAN 4000 an architecture that behaves logically much like a distributed bus.

PLAN 4000 operates at a data rate of 2.5 megabits per second and will support multiple network segments. The data-path media for the network is RG-62 coaxial cable and standard BNC connector hardware. Each network segment supports up to 255 workstations and servers. Maximum cable distance between any two stations on a network segment is 4 miles. Special network components, known as Line Isolation Devices (LIDs), permit clusters of workstations to be separated by as much as 2,000 feet. Individual workstations or servers connected to a LID may be up to 2,000 feet from that LID. A 4mile-long network would contain 22 intervening LIDs. The LIDs give PLAN 4000 its distributed-star physical topology. Figure 1 shows a typical PLAN 4000 network with workstations, servers, and LIDs, illustrating the distributed-star topology. Servers available for PLAN 4000 include file servers, file-transfer servers, print servers, and 3270 emulator servers. Operating systems supported are PC DOS and UCSD p-System for the IBM PC; DOS, CP/M, and Apple Pascal for the Apple II; and SOS for the Apple III. Electronic mail software is available as an application for the network environment.

Figure 1: PLAN 4000 Local Area Network

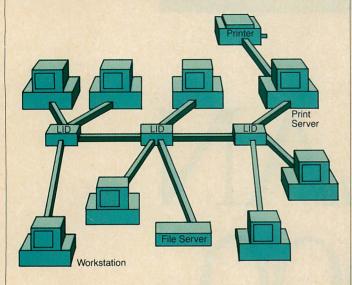
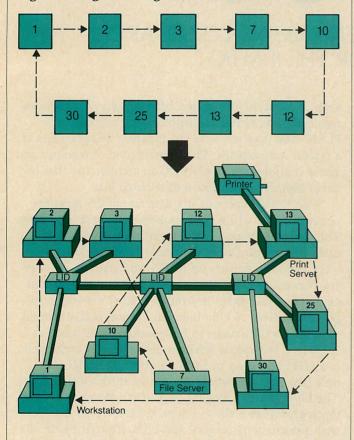


Figure 2: Logical Ring Structure of PLAN 4000



### HARDWARE COMPONENTS

Plan 4000's component hardware features include network interface cards, Line Isolation Devices, cable media, file servers, file-transfer servers, print servers, and emulator servers. The system's physical topology can be configured in numerous different ways. Readers familiar with the Datapoint Arcnet system may realize that network interface cards, LIDs, and the cable media are based on the Arcnet local area network design. The same is true for the token-passing access scheme.

**Network Interface Cards.** Network interface cards are required in each workstation and server on the network. They are equivalent to Arcnet resource interface modules, which are used in both Datapoint and Radio Shack local area networks. The card has both an 8-bit station address selector for use in a single network segment and a unique 48-bit Ethernet address that allows internet operations using the Xerox Network Service (XNS) protocol. With appropriate internet addressing and multiple network interface cards, a single device may operate on more than one network segment.

The network interface card implements the Arcnet layer 1 and layer 2 protocols through a custom 3-chip set on the card. It supports a network speed of 2.5 megabits per second and a PC RAM-to-network buffer transfer speed of 381 Kbytes per second. The card contains 2 K of RAM for buffers, 2 K of RAM for programming, and 4 K of ROM. Physically, the card is a standard IBM PC expansion card, with one BNC-type connector on the rear faceplate. The network interface card may be plugged into any slot on the PC or XT expansion bus.

Line Isolation Device (LID). The LID corresponds to an active hub in the Arcnet system. Its functions are: to condition signals going from nodes to the rest of the network; to electrically isolate workstations and other devices from the rest of the network; to terminate the cable segments; and to route the signals in up to 10, 20, or 30 multiple directions. The isolation feature is particularly significant because it prevents line noise due to multiple taps; such noise is generally found in a distributed-bus network. There are no direct cable taps in the PLAN 4000 network. Signal routing is accomplished by the inclusion of 10, 20, or 30 multiple connection ports. A 30-port LID is contained within the file server, allowing it to function as a network hub for up to 29 devices, thus increasing the flexibility of system configuration. Transmission Media. Network signals are trans-

mitted through RG-62 coaxial cable, an inexpensive cable similar in size to the more familiar RG-59/U, which is used in radio communications systems. Connecting hardware is the same BNC-type used in the two networks discussed previously in this series. This is the same cable used with IBM-3270 terminal systems and with the Datapoint Arcnet system. As previously mentioned, PLAN 4000 does not allow or require direct taps

into the network cable. All connections are made through LIDs or network interface cards. Maximum cable run between any two termination devices (network interface card, LID, or File Server) is 2,000 feet.

**File Servers.** A file server gives the PLAN 4000 network its real power in distributed processing applications. This device is a proprietary server that uses an 8-megahertz MC68000 and 256 Kbytes of RAM as its self-contained data processor. The server supports up to four 60- or 137-Mbyte formatted hard-disk drives and up to four 20- or 45-Mbyte streaming tape-cartridge drives for backup purposes. The network may be configured with multiple servers, allowing significantly large amounts of shared storage. The server contains a 29-port LID capability, the standard network interface card, and a clock-calendar card. The built-in LIDs allow the user to establish special-purpose subnetworks through the use of devices directly connected to the system.

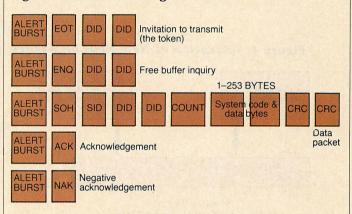
File servers contain a resident volume-management program, which bears a distinct resemblance to IBM PC DOS 2.0 and its file management system. The volume management program orchestrates the establishment of variable-size and logical volumes and, in conjunction with software on user stations, handles backup, password protection, access control, error checking, and retransmission. The volume-management software is controlled through an attached local console or terminal, which communicates with the server at 9,600 baud. Additionally, control can be exercised from a remote console location through an attached modem. This method uses the dial-up phone system and communicates at 1,200 baud. Print Servers. Print servers are workstations with appropriate printer and network-interface cards and a software package that runs both on the server and on individual user workstations. The hardware package consists of either a dedicated Apple II with 64K RAM and a network-interface card or an IBM PC with 128K RAM and a network-interface card. Multiple print servers may be attached to the network. Each server can support up to six printers if the appropriate printer adapter cards are provided. As with other network devices, a single print server may operate on more than one network segment, allowing physical centralization of printer resources.

The installed software package interacts with a designated file server to print user files according to parameters requested by the user. For example, there are four priorities for printing files, high, standard, low, and overnight. The print server may request up to eight files at the same time from a volume on the file server. Up to 999 multiple copies can be printed from a single request. The user completes a print-request form on his or her workstation to set up the required print jobs. This form is sent to the file server and stored as a "mini volume." The print server queries the file server approximately once every minute to check for outstanding print re-

# -Plan

4000 DOES NOT ALLOW OR REQUIRE DIRECT TAPS INTO THE NETWORK CABLE. ALL CONNECTIONS ARE MADE THROUGH LIDs OR NETWORK INTERFACE CARDS.

Figure 3: Arcnet Message Structure

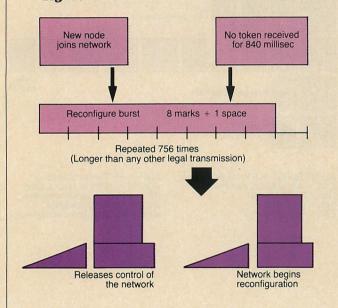


ALERT BURST = 6 intervals of mark EOT = ASCII end of transmission

DID = Destination ID SID = Source ID ENQ = ASCII enquiry SOH = ASCII start of header COUNT = Number of data bytes CRC = Cyclic redundancy check ACK = ASCII acknowledge NAK = ASCII negative acknowledge CSMA

IS BASICALLY A STATISTICAL
ALGORITHM, WHICH MEANS
THAT WE CAN PREDICT NEITHER
HOW MANY COLLISIONS WILL
OCCUR OVER TIME NOR HOW
LONG IT WILL TAKE THE
NETWORK TO RECOVER FROM
COLLISIONS.

Figure 4: Activation of New Node on Arcnet



quests. Once the user completes a print request, he or she will have no further interaction with the print server until notified that the job is complete.

File-Transfer Servers. These servers allow files to be transferred between two or more file servers on the same network segment, between file servers on dissimilar network segments, and between file servers on remote networks. Hardware consists of either the Apple II with 64K RAM or the Apple III with 128K RAM, network interface cards, and appropriate modems. Modems suitable for the Apple II are D.C. Hayes Micromodem II®, Owl Ltd. Owlmodem®, and the Novation Apple-CAT II®. The D.C. Hayes Smartmodem series is used for the Apple III version of the server.

If the server transfers files only within the same or a connected network segment, a modem is not required. A clock/calendar card is required in order to allow unattended and time-sequenced file transfers. In a network configuration, the file server provides the clock/calendar capability. This particular feature is one of the more useful aspects of the PLAN 4000 file-server concept. If the network users so desire, the file-transfer server can operate totally automatically, running a preset schedule of file-transfer events. I will discuss this feature in more detail later in this review. Alternatively, the file-transfer server may revert to a normal network workstation if the server capabilities are not needed. The server maintains a log of all its activities and uses its own command language, consisting of some thirty-four keywords. It is fully compatible with and supports the Nestar MESSEN-GER electronic mail software package.

**IBM 3270 Emulator Server.** The IBM 3278 Emulator Server allows up to sixteen workstations on the PLAN 4000 network to function as IBM 3270 display stations. The server communicates with mainframe computers that support the 3270 bisynchronous protocol. In essence, the server appears as an IBM 3274 Cluster Controller to the mainframe. User stations can be any combination of Apple IIs, Apple IIIs, and IBM PCs. Also required for the server is a high-speed modem, which, if the appropriate leased telephone lines are available, allows communications at speeds up to 9,600 baud.

# THE TOKEN-PASSING PROTOCOL: HOW IT WORKS

Needless to say, there are vocal supporters both for contention systems, such as CSMA/CD, and for token-passing systems, such as PLAN 4000 and Arcnet. The following simplified description of the token-passing protocol points out, without editorializing, the major ways in which this protocol differs from the CSMA systems surveyed in the previous two articles.

Perhaps the major difference between the two technologies is that CSMA (with or without collision detect) is basically a statistical algorithm, which means that we

can predict with certainty neither how many collisions will occur over time nor how long it will take the network to recover from collisions. Token-passing, on the other hand, is a very predictable method of controlling network access. A short, structured message, known as the token, is passed from station to station at regular intervals, the sequence of stations being determined by the logical structure of the network. A typical logical structure—one that corresponds to the physical network shown in figure 1—is shown in figure 2.

This token-passing protocol has several unique features:

- Each node remembers the address of the node to which it last passed the token; in effect, the network maintains a list of active nodes dispersed throughout the network.
- 2. The protocol supports a broadcast mode in which messages are sent to all nodes without acknowledgement.
- 3. All transmissions except broadcasts must be acknowledged.
- 4. A message called the *free buffer enquiry* is sent prior to any data packets to verify that there is space available for data in the receiving node's buffer.
- 5. Only a single path may connect any two nodes.
- 6. The signal-passage time between any two nodes may not exceed 31 microseconds.
- 7. The protocol can be implemented on a variety of baseband or broadband modulation systems.
- 8. The protocol supports five types of messages (see figure 3). Each message is preceded by an *alert* burst that signals activity on the bus.
- 9. The basic information entity is an 11-bit sequence consisting of an 8-bit character preceded by two marks and a space.

The Arcnet protocol differs from CSMA-type protocols in that it manages reconfiguration in a predictable manner: reconfiguration results from a node entering or leaving the network. The system also describes any other event that causes the token to be destroyed, such as excessive line noise. In simple terms, if a node leaves the network, that node will not respond to an attempt to pass the token to it; the sending node waits 74 microseconds for a response and then increments its "next ID" counter, sending the token to the next node.

The network response when a node enters is somewhat more complex. Figures 4 and 5 show the sequence that occurs when a new node joins and how the network reconfigures after such a juncture. Contrast this behavior with a CSMA-type network, in which a node desiring to enter need only listen for a no-carrier condition on the bus before transmitting. The average time for a new node to enter a network cannot be predicted with certainty for a busy CSMA network.

One final aspect of the Arcnet protocol that deserves

Figure 5: Arcnet Reconfiguration

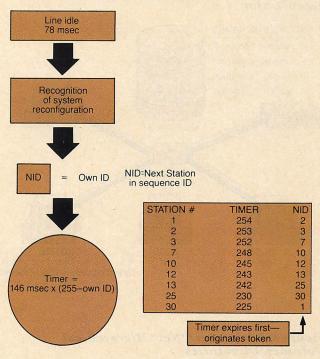


Figure 6: Interaction of PLAN 4000 and Host Processor

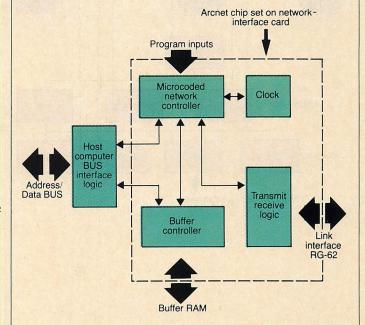


Figure 7: PLAN 4000 File Server/Network Organization

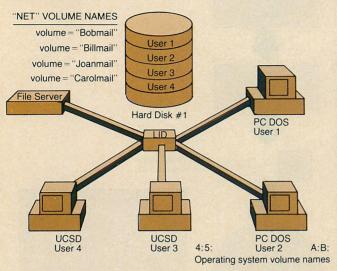
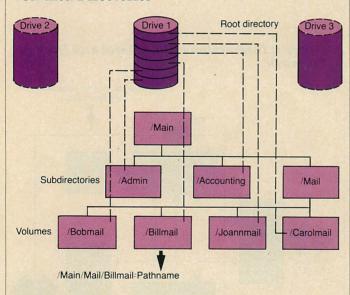


Figure 8: File Server/"Net" Hierarchical Volumes/Directories



comment is the processor/network interaction. The processor is concerned only with transmitting and receiving data packets; it is not involved in the details of token passing. This functional separation is shown in figure 6.

# NESTAR PLAN 4000 SOFTWARE AND NETWORK OPERATION

As in most microcomputer installations, the real interest of local area network users lies not in the hardware or communications technology but in the software and applications that are available for a specific network. PLAN 4000 is well endowed with software that makes the network a truly useful tool. This software includes a high-level network operating system that manages file-server operations, specialized software that operates the various attached servers (other than file servers), and an electronic-mail software package. The essential features of these software packages are as follows:

**NET Software.** File-server management is provided by internal software that runs on the file-server MC68000 processor and by a series of files, collectively known as NET software, executed on each workstation. Briefly, the NET program at each workstation allows its user to:

- 1. create volumes on the file server hard disks
- 2. access these volumes by "mounting" them on virtual drives
- 3. otherwise share and control access to hard-disk space The NET program is a high-level user interface to the file-server software. It does for hard-disk drive management what the host operating system does for individual files on a hard disk. The structure of NET hard-disk management closely resembles the hierarchical file structure of PC DOS 2.0, but NET is not otherwise related to that specific DOS. NET programs are designed to work in the following six environments if the appropriate modifications are made to the host operating system:
- 1. IBM PC DOS
- 2. IBM PC UCSD p-System
- 3. Apple II DOS
- 4. Apple II CP/M
- 5. Apple II Pascal
- 6. Apple III SOS

In this review, I will focus on the operation and features of the NET software as seen by a workstation user and the general capabilities of file-server internal software.

Some basic terminology and information about organizational relationships are provided in figures 7 and 8. Figure 7 illustrates the logical subdivision of the file server and its relationship to individual workstations with their host operating systems. Figure 8 shows a hierarchical volume organization that might exist on the network that is shown in figure 7.

A potential source of confusion with this network is the possible dual naming of hard-disk sectors on the file server. In the NET environment, these sectors are known as volumes or "virtual diskettes" and have a hierarchical file structure of volume names. On the operating-system level, the same segments of the hard disk are considered to be diskette drives of appropriate size and are referred to by the usual drive designators (A:, B:, C:, etc. for IBM PC DOS). It is not inconceivable that a user might work on the NET level to create and control access to volumes on the file-server hard-disk drives; the same user would then access individual files on that volume by the usual DOS file-level commands.

The term *mount* refers to the process of making a specific volume, or "virtual diskette," accessible by a user's DOS. In this sense, "mounting" is equivalent to inserting a diskette into a physical drive. "Unmounting" is just the opposite—removing a volume from access by the user's DOS. A volume must be mounted by NET before its files can be manipulated by the host DOS.

Commands to control the file server fall into six general groups.

- 1. Commands concerned with creating, deleting, naming and protecting virtual diskettes on the hard disk
- 2. Commands concerned with mounting virtual diskettes at a workstation
- 3. Commands associated with binary virtual volumes
- 4. Commands concerned with file locking
- 5. Commands that set default values for designating pathnames
- 6. Commands that give information at the terminal The fundamental element of most of these commands is the "pathname." Pathname usage is almost identical to the syntax used in IBM PC DOS 2.0. The general structure of a NET pathname is

# /diskname(rootdirectory)/subdirectory/ subdirectory/. ../volume

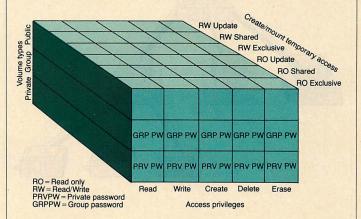
Any part of the pathname, up to and including the last subdirectory, may be made a default pathname to reduce input required during NET operations. In a NET pathname, elements are directories and volumes; in a DOS 2.0 pathname, elements are directories and files.

When a volume is CREATEd on a hard disk, it is given a name and assigned to a specific directory. Its size can vary within the limits allowed by the host operating system. The host system is also specified by the CREATE process. Perhaps the most significant parameters in the CREATE process are the protection and access levels assigned to a particular volume. A volume can be PUBlic, allowing any user to access without passwords; GRouP, allowing access with group passwords, or PRi-Vate, allowing access only by use of a private password. Passwords are encrypted and cannot be recovered by debug procedures. For each of the volume types, there is a choice of any combination of READ, WRITE, CREATE, DELETE, or ERASE privileges. DELETE removes an en-

# The

NET PROGRAM IS A HIGH-LEVEL USER INTERFACE TO THE FILE-SERVER SOFTWARE. IT DOES THE SAME JOB FOR HARD-DISK DRIVE MANAGEMENT THAT THE HOST OPERATING SYSTEM DOES FOR INDIVIDUAL FILES ON A HARD DISK.

Figure 9: PLAN 4000 Protection Features



The

TYPE OF VOLUME (PUBLIC, GROUP, OR PRIVATE) AND ITS ACCESS PRIVILEGES (READ, WRITE, CREATE, DELETE, ERASE) DEFINE A MATRIX OF PERMA-NENT VOLUME-PROTECTION CHARACTERISTICS.

Figure 10a: Print-Server Options. One File Server Services Three Print Servers.

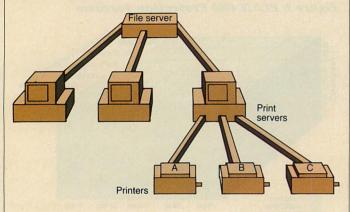
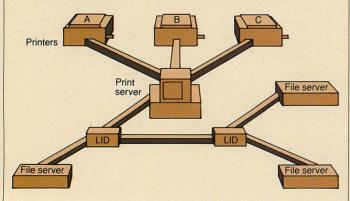


Figure 10b: Print-Server Options. One Print Server Configured for Three File Servers.



try from the directory, whereas ERASE removes the volume completely from the hard disk.

The type of volume (PUBlic, GRouP, or PRiVate) and its access privileges (READ, WRITE, CREATE, DE-LETE, ERASE) define a matrix of permanent volume-protection characteristics. These are in effect as long as the volume remains allocated on the hard disk. In addition, temporary usage levels are superimposed on the permanent matrix. When a volume is CREATEd or MOUNTed, the temporary access restrictions may be invoked if the user desires. Temporary access may be either READ ONLY or READ/WRITE; each of these may have a choice of SHaRed, EXClusive, or UPDate usage. For example, a volume mounted by one user with READ/WRITE, UPDate temporary protection may be accessed by other users with a READ ONLY, SHaRed privilege. Other combinations provide a range of temporary protection levels to the user.

A third form of protection exists at the resource level, which includes files and I/O devices. This protection, called a *lock*, is cooperative in that applications programs or DOS batch files must honor the access protection. Locks can be set on a file or on an I/O device such as a printer for either EXClusive or SHaRed use, depending on whether more than one user can set the lock on a shared resource. Locks are controlled at the command level of DOS. Protection features offered by PLAN 4000 are summarized in figure 9.

**File-Server Utility Operations.** The file server itself has software that is controlled from a console terminal at the server. The general capabilities of file-server software are utilitarian in nature and include the following functions:

- 1. partial tape dump/restore
- 2. full tape dump/restore
- 3. copy partial or full disk to disk
- 4. list disk contents
- 5. examine/modify disk contents
- 6. check disk consistency
- 7. format and repair disks
- 8. modem on/off
- 9. add/modify tape dump instruction files
- 10. edit file server startup file

These capabilities are usually run from the attached console but can also be run from a remote console through a modem port on the file server. My discussion of these capabilities will be limited to the tape backup features and their associated instruction files.

Both partial- and full-tape dump options use a 45 megabyte, <sup>1</sup>/<sub>4</sub>" tape cartridge, integral to the file server unit. The partial dump requires thirty to ninety minutes to back up a 60-megabyte hard disk; the full dump takes twelve minutes to fill a 45-megabyte cartridge and eighteen minutes to complete a 60-Megabyte backup. Options available for partial backups include:

- 1. save volumes by modification date criteria
- 2. purge volumes by last read/write date criteria
- 3. save and/or restore selected volumes
- 4. save and/or restore selected volumes under specified directories

Tape-dump instruction files can be created to automatically execute frequently performed tasks. Up to eight of these are allowed, and five of them can be preset on system delivery. Some examples of canned operations include daily backup, archive/purge, software distribution, large-volume interchange, and disk compaction. These operations may be modified or others created. The task of backing up system disks is best left to an individual designated as the system manager, because in most organizations data integrity is too critical to be put in the hands of all network users.

**Print-Server Operation.** The print server is an Apple II or IBM PC workstation with added I/O cards to handle printers and the software required to interact with one or more file servers. The print server also requires one or more network interface cards, depending on the number of network segments to be serviced. When a network printing service is established, there are several options available for print-server topology. Three of these are illustrated in figures 10a, 10b, and 10c. Each of these options requires appropriate setup within network software. The initiation and maintenance of print-server configuration files is another job appropriate for a system manager, who would be responsible for:

- 1. creating and maintaining configuration files that tell the print server(s) what options are desired—network segments to be serviced, file servers to query for print files, connected printers and their setups, and so on
- 2. maintaining print job queues, including the purging of invalid print requests
- 3. presetting desired defaults in print request forms The print server operates on a priority-queued basis with multiple printers and provides the intelligence to interact with a specified file server or servers. This interaction allows files to be printed in order of priority and with other user-desired options. The interaction between the print server, file server(s), and user workstations is shown in figure 11.

Exact user interface is determined by the host operating system, but the general options available are shown in table 1, which includes a brief explanation of what each option provides. Once these options are selected, the print-request file is created and sent to the appropriate file server as a "mini-volume." Print-request volumes are listed under a special directory on the file server. The file server is interrogated periodically by the print server to determine what print-request files exist and what their proper execution sequence is. Once a job is begun on a specific printer, it is completed, even if

Figure 10c: Print-Server Options. Different Network Segments from One Print Server

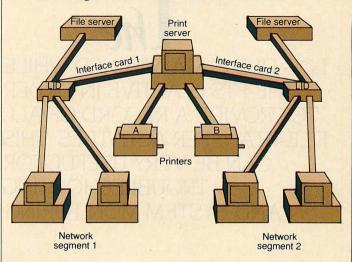
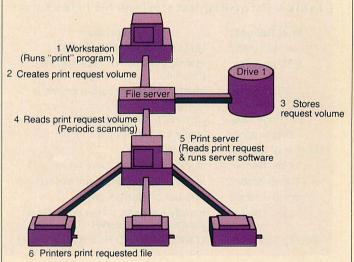


Figure 11: Print Server/File Server Interaction



# The

LOG FILE IS MAINTAINED WHILE
THE FTS IS ACTIVE IN ORDER
TO PROVIDE A RECORD OF ALL
FILE-TRANSFER ACTIVITIES. THIS
CAN BE VERY USEFUL FOR
TROUBLESHOOTING
AND SYSTEM MONITORING.

# Table 1: Print-Request Options for Print Server

Print Request	Options
File(s) to print?	Up to 8 from a single volume
FS Pathname:	Identify the volume containing the print files
File Server:	Identify the server containing the print- file volume
Page Title:	Optional 5-line title header
Identification:	Name for the print job
Number of Copies:	Up to 999
Print Server:	Identify the desired print server
Printer Model:	Identify the specific printer desired
Eject (0 = none):	Number of lines per page
Setup:	Identify a specific printer setup file on the desired print server
Priority (L/S/H/O):	LOW/STANDARD/HIGH/OVERNIGHT

### Table 2: FTS Command-File Keywords

ALWAYS AT BEGIN CONNECT TO SITE DEFINEAS DELETE DIR DO END DO END EVERY EXIT	FILE FORTIMES HOUR(S) ID IS PHONE LIST MINUTE(S) MYSITE NFS MYSITE NFS NOLIST NOLOG	PASSWORD RECEIVE REPLACE RETRY IN SEND SET CHAIN SITE SLOT STN SLOT STN TO USES VOI
		VOL

the printer gets new print requests with higher priority. **The File-Transfer Server.** The File Transfer Server (FTS) is one of the unique and powerful features of PLAN 4000. Figures 12 through 15 illustrate the possible ways to accomplish file transfers.

To clarify the operation of the FTS, I will discuss a specific example of remote file transfer using the FTS command language. In order for a workstation to become a part-time or full-time FTS, it must run at least the FTS software. A connected modem is required for remote file transfers, and a network interface card is required for every network segment to be serviced. A clock/calendar card is required for the automatic features of the FTS command language; in a network environment, the file server contains the clock/calendar card.

The file-transfer server can transfer the following bjects:

- 1. file-server volumes of all allowable operating systems
- 2. binary image volumes
- 3. text files (print-server spooled files, electronic mail)
- 4. file-server directories
- 5. Apple II Pascal and Apple III SOS files Obvious omissions from this list are IBM PC DOS and UCSD p-System files; presumably these will be included when IBM PC FTS software becomes available.

FTS is designed to operate in a fully automatic mode, although that mode can be overridden by operator intervention, and the server can be reverted to a normal workstation function. The FTS software is written in Apple Pascal and uses two types of files: a log file and a command file. The log file is maintained while the FTS is active in order to provide a record of all file-transfer activities. This can be very useful for troubleshooting and system monitoring. The command file is the heart of the FTS system and will be described in further detail, including an example of usage.

The command file is read and compiled by the FTS software to generate a list of activities to be performed. Those operations to be carried out immediately are called *globals*; the remaining activities are time-scheduled and are called *procedures*. In command-file format, a procedure might look like

### **BEGIN Task 1**

SEND VOL /main/personnel/engineering, FILE roster; TO VOL /main/personnel/ship, FILE recall;

END

In this case, the procedure name is Taskl. Once the procedure is defined it can be scheduled:

AT 0900 DO Task1

01

**EVERY n HOURS DO Task1** 

Table 2 lists the 34 allowable keywords used in command files. As you can see, the FTS capabilities are quite extensive. Once in automatic mode, FTS continually scans for operator interrupt via the [ESC] key and for incoming phone calls if a modem is attached. If the operator intervenes, the following menu is presented:

# (C)ontinue (P)assword (Q)uit (S)chedule (R)estart

The (S)chedule option allows the operator to hand-schedule an FTS procedure.

Figure 16 shows a sample command file controlling the FTS at a home office and at two district offices. The file is set up with the procedures defined in the beginning, followed by the desired time sequencing. At 1:00 AM every morning, daily text (a Pascal file) is moved from one volume to another on the home-office hard disk. At 3:00 AM every morning, the home office initiates a remote connection using the AT command line and the "calldistrict1" procedure. In order to start the transfer, the home-office FTS checks the "district1" IS PHONE and USES clauses to find out what phone number to dial and what modem mode to use.

"Home" calls "district1" using a 300-baud modem data rate. It then transfers the file daily text on the volume /main/users/reports with an ID of "update." "Districtl" is set up to receive an object with the ID "update" and is otherwise compatible with modem and data rate. Once the transfer is completed, "district1" checks for a CONNECT TO SITE home command; since that command exists in "district1" 's command file, an object called "april" is transferred from "district1" to "home." At 4:00 AM every morning, "home" dials "district2," changing its modem rate to 1,200 baud to match that of "district2." The object called "update" is again sent, and "district2" sends the object called "payroll" to "home." 3270 Binary Synchronous Communications Emulator. The final PLAN 4000 subsystem to be described in this article is the 3270 Emulator Server and its associated workstations. In a typical IBM-mainframe remote-job entry application, a 3274 remote cluster controller is connected to the mainframe via modem and leased line or direct connection. The protocol used between the controller and the mainframe is binary synchronous. In such a system, some number of 3278 remote terminals is hardwired, using connection ports, to a single 3274. A combination of hardware cards and software allows one workstation to become a 3274 controller emulator and up to sixteen other workstations to become 3278 terminal emulators. The 3274 emulator uses a bisynchronous communications adapter card for connection to a modem or mainframe, a network interface card for PLAN 4000, and software to conduct bisync communications and to recognize other workstations as 3278

emulators. The 3274 emulator is also called the gateway

Figure 12: FTS Intranetwork Transfer

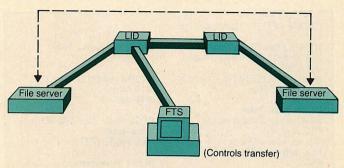


Figure 13: FTS Intersegment Network Transfer

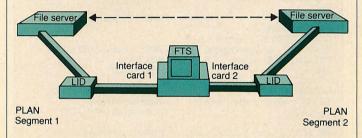


Figure 14: FTS Network-to-Network

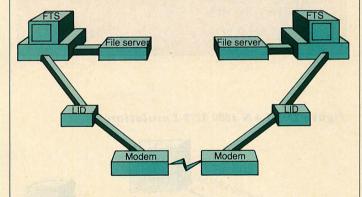


Figure 15: FTS Network-to-Standalone

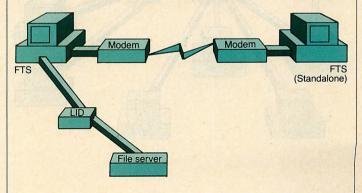


Figure 16: FTS Command File

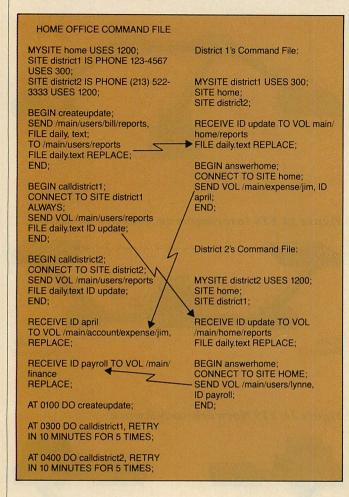
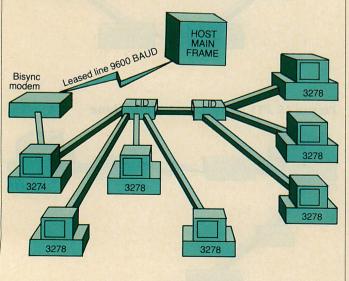


Figure 17: PLAN 4000 3270 Emulation



station, as it connects two dissimilar network protocols.

The emulators run in the UCSD p-System environment, which the system manager (a very busy person!) can set up to boot automatically for a 3278 emulator user. More than one 3278 emulator can share a virtual 3274 port on the gateway; software prevents conflicts on shared ports and allows the use of optional passwords to control access to the gateway. Software on the 3278 emulators allows users to set up keyboard sequences and display to emulate those of the 3278. Interaction with the host mainframe is identical to that used by the actual 3278. The 3278 emulator station can terminate the 3278 connection to the gateway by menu action, thus reverting to a normal network workstation. A typical 3270 emulation configuration existing on PLAN 4000 is shown in figure 17.

#### **EVALUATION**

I think it is clear that PLAN 4000 has taken a big step toward bringing maturity to the IBM PC local networking market. The variety of servers and network-support software, combined with a full spectrum of topological possibilities, makes this a powerful communications tool for a business or corporate entity. The major drawback of PLAN 4000—its high initial cost—will be addressed with PLAN 3000, which will use a lower-cost dedicated file server, and PLAN 2000, which will use IBM PC-XTs as servers. Applications software, currently represented by the Messenger electronic-mail system, is of high quality but is in short supply. This is an industry shortcoming that is already improving. PLAN 4000 will be a viable force in the IBM PC local area network picture for the foreseeable future.

Companies mentioned in this article:

## HAYES MICROCOMPUTER PRODUCTS, INC.

5923 Peachtree Industrial Blvd. Norcross, GA 30092 404-449-8791 CIRCLE 462 ON READER SERVICE CARD

#### NESTAR SYSTEMS, INC.

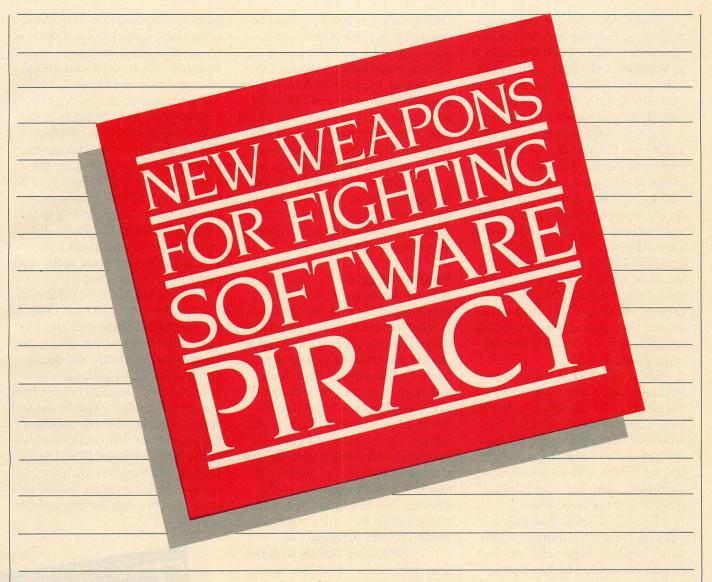
2585 E. Bayshore Rd. Palo Alto, CA 94303 415-493-2223 CIRCLE 463 ON READER SERVICE CARD

#### NOVATION, INC.

20409 Prairie St.
Box 2875
Chatsworth, CA 91311
800-423-5419 or (in California) 213-996-5060
CIRCLE 464 ON READER SERVICE CARD

#### **OWL ASSOCIATES**

2755 North Ave. Grand Junction, CO 81501 303-245-2303 CIRCLE 465 ON READER SERVICE CARD



WERNER L. FRANK

here have been legions of efforts to deal with pirates of software. Included among these are pure software schemes that depend upon encryption of the program, certain hardware techniques that operate via special purpose plugs or ROMs and whose presence allows the software to function, and complex diskette formatting tricks that take advantage of knowledge of the operating system and its treatment of diskette storage sectors and tracks.

In an effort to achieve more successful deterrents to software piracy, the Association of Data Processing Service Organizations (ADAPSO) has

# ADAPSO identifies four solutions; the Prolok disk seems the most promising.

taken leadership in organizing a clearing house for information on technological solutions to software piracy. In the late summer of 1983 this clearing house solicited responses from vendors who purport to provide solutions for constraining the piracy problem. Information was sought, according to a specified outline, which describes commercially available protection products. The plan was to cir-

culate these submissions for comment among interested parties in an effort to raise everyone's consciousness as well as feed these recipients' views back to the originating vendors.

The guidelines defining the "perfect" technological solution have actually been established and are available from ADAPSO. They deal with cost of the protection scheme, its ease of use, availability and installability, the requirements placed on the hardware and the operating system, if any, and the degree of actual protection that is achievable. The latter point seems to serve the view that no protection scheme can be absolute.

# SOFTWARE PIRACY

Indeed, the above procedure has reached its first step with submissions from four vendors: Vault Corporation of Westlake, California, with its PRO-LOK product; Remote Systems Inc. of McLean, Virginia, with SECURE-WARE: Export Software International Ltd. of Edinburgh Scotland with OPY-LOCK; and CSLabs with its Software Protection Device. The latter organization believes that a software-only solution will not suffice. Accordingly, CSLabs has focused on a hardware approach requiring the installation of a special device on a serial RS232 line. The CSLabs protection scheme would be keyed to a specific piece of software and subsequently must be present whenever that software is executed. Unprotected software would be ignored by the device. The offering is priced at \$150.

SECUREWARE is a similar product employing a hardware "lock" installed on an RS 232 serial or parallel port. The embedded controller contains lock combinations for the handling of up to 15 separately protected programs, each with its own unique encryption code. The unit price for this solution is around \$35.

The COPYLOCK product is a software approach claiming to introduce a unique "fingerprint" on each physical diskette. This fingerprint is visible only to the properly protected software, that is, prepared by the vendor in accordance with the COPYLOCK procedure. This requires a special COPYLOCK detection code to be included in the executing version of the compiled software as well as the incorporation of the run time program on the specially prepared diskette. These disks are available in quantity for about \$7.50 per unit.

A similar and seemingly more expeditious and cheaper approach, is offered by the remaining respondent, Vault Corp. It is the Prolok disk, and it seems to come very close to satisfying the stiff guidelines set by ADAP-SO for qualifying a "perfect" protection scheme. Some of these tough characteristics that need to be met by a qualified product are as follows: it

must have a very low cost, must be insensitive to the hardware and operating system for which it was configured, as many back up copies of the software as desired must be able to be made, software must continue to be protected even if it is stored on a hard disk, presence of the additional software providing the protection must not be visible to the end-user, it must give freedom to the user to execute the application on any hardware system for which the diskette is configured, program execution must not be unreasonably degraded.

## **Prolok Magic**

What is this magic? Prolok disk is a conventional 51/4 inch, double density, double sided diskette produced by a special patent-pending "fingerprint" process that could be viewed as a hardware-like imprint. Each such disk is given its own, unique identifier, currently some 100,000 codes but in a future version closer to one million. Once a piece of software is associated with a fingerprint, the program must confirm the presence of that key at every execution of the software. It is this specialized media. merchandised by Vault Corporation, which provides the protection.

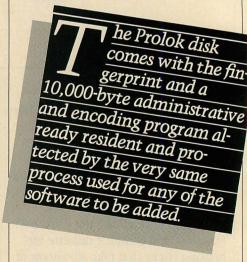
The Prolok disk comes with the fingerprint and a 10,000-byte administrative and encoding program already resident and protected by the very same process used for any of the software to be added. The procedure to place software that is to be protected onto this disk is as follows: 1. Insert the Prolok disk in the default drive. 2. Insert the disk containing the program to be locked in any other drive. 3. Type a variation of a simple copy command as follows:

# PROLOK B:FILENAME.EXT A:FILENAME

where B is the drive holding the program to be copied and A holds the Prolok disk. The program moved from drive B to drive A is now protected having been encrypted during the copy process and tied to the presence of the unique fingerprint. This

program can, therefore, only be executed if the related Prolok diskette is mounted on the default drive. In the meantime the encoded software can be copied from the Prolok disk as many times as desired in order to both generate back up copies as well as position the software on a hard disk. In the latter case, execution from hard disk would require the presence of the Prolok disk in the default drive. This disk must contain the fingerprint corresponding to the encoded software. The Prolok disk must remain in the default drive as long as there is reference to the application's start up segment.

At this point, the locked application has been encrypted and there has been added to the code an additional 3000 bytes, which ties the program to the fingerprint and decryption process. The application, in its protected form, remains callable from the normal operating system and will appear as expected in the associated directory. Note that, unlike the case of the aforementioned COPYLOCK product, the Vault approach does not require changing the application code itself prior to being incorporated into



Werner Frank's company, Werner Frank Computer Group, provides management consulting services to computer hardware and software vendors and users. Frank was previously a cofounder of Informatics General Corporation and was associated in an executive capacity with that company for 20 years. the locked environment.

The Prolok disk can be filled with many locked, or for that matter, unlocked programs limited only by that disk's capacity. While the COPY function is operative as shown above, the DISKCOPY command will not work. Now this capacity of the Prolok disk can lead to some creative organization of the application software. Several options are available to the vendor. First, the entire program can be locked requiring, therefore, the presence of the Prolok disk whenever there is any loading of memory from the storage. A second approach is to encode only the initiating segment that will be presumed core resident during the entire execution. In this case the Prolok disk can be removed after the start up and free the disk drive for other purposes. This option is especially helpful for protected disk resident software.

A third technique is that which requires intermittent refresh of memory with parts of the code, or perform overlaying with encoded segments. This latter approach provides additional protection for the software from those copiers who attempt memory snapshotting in order to capture the executing program.

In the event that the Prolok disk becomes inoperable with respect to a specific encoded application, it is easy to recopy, from the backup, the locked version of that program. If the Prolok disk itself is damaged, the chances that one can proceed are still high, since the fingerprint may still be operative. In this case, with the Prolok disk in the default drive, the back-up copy can be placed in some other drive and the execution will take place. If the entire disk is damaged, a new Prolok disk must be purchased and the process renewed.

Because the encryption can be unique for each disk, the Vault process has one more benefit going for it. This means that having cracked one instance does not provide a solution for the next. Hence, rapid changes in the software, in terms of new releases, can be an added deterrent and

he use of a protection scheme such as that offered by critics. There are those who to find a perfect solution eventually be cracked.

help in combating the production of illegal copies. End-users will not find it economically useful to be out of synchronization with the most current version of the software.

Prolok is presently available for operation with CP/M, MS/DOS and APPLE-DOS operating systems and hardware from Apple, Atari and IBM, plus the IBM plug compatibles.

The use of a protection scheme such as that offered by Vault is not without its critics. There are those who believe that it is impossible to find a perfect solution and that any effort can eventually be cracked. Even Vault admits to this fact since one of its Beta sites was actually reported to have penetrated the proprietary process. However, this same organization is now claimed to be using the Prolok scheme since it appears to be the best alternative available on the market today. Incidentally, this alleged company has a sophisticated laboratory for analyzing and breaking protection schemes, a situation not generally available. This does point out the key issue on the subject of protection. Willful desire to break a code with high powered equipment and skilled technicians can probably not be thwarted. At best a good protection scheme will introduce delays in the pirating activity. Hence, professional pirates will likely continue their operations. A good protection process will, however, eliminate, for the most part, the more casual illicit duplicators of diskettes.

Another issue concerns the use of protected software in multi user

environments such as that found in Local Area Networks. Here it is desirable to store one copy of the software on a shared hard disk and allow all users to have access to the program. Using the Prolok technique would require a key (the Prolok disk) to be available at each user station. This is possible in the close environment of a LAN by simply passing the Prolok disk around to the community of users. This presumes that this disk is only needed during start up and not during the entire session. We have already seen how this situation can be avoided by organizing the software to require periodic refreshing from the hard disk.

This begs, of course, the desired solution and Vault is busy coming up with a suitable manner to handle the multi user LAN case. Indications are that a future release of the system will meet this contingency.

One wonders about the proprietary process used by Vault. Many speculations have appeared in the press but none seems to have identified the methodology used. The speculation ranges from assertions that the fingerprint is not a magnetic force, but rather built into the media itself to views that suggest the basis of the approach to be non standard arrangement of sectors to which the fingerprint provides the map.

The protection scheme offered by the Prolok technology can be used by an individual, a company, or a software vendor. Vault Corp. is making available a number of distribution alternatives in order to satisfy a wide

# SOFTWARE PIRACY

range of potential users. First of all, one may purchase a Prolok disk outright, each with its unique fingerprint and the Prolok software. The price begins at \$9.95 in units of one, dropping to \$3.60 per high-quality, 5½ inch diskette for larger orders.

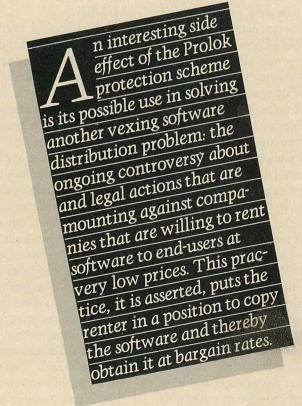
Vault will also provide fingerprints on customer-supplied diskettes for from \$.75 to \$1.25, depending upon quantity. This alternative provides some clue as to the Vault process since it apparently does not depend upon the actual manufacturing of the disk in the first place. Finally, it is possible to employ mass duplication equipment in producing Prolok diskettes with a locked application all set for the market. This is done by using hardware offered by such vendors as Foremaster and ADC. The price for mass duplication ranges from \$3.10 per disk in quantities of 500 to \$2.10 per disk if quantities of 100,000 are ordered.

An interesting side effect of the Prolok protection scheme is its possible use in solving another vexing software distribution problem: the ongoing controversy about and legal actions that are mounting against companies that are willing to rent software to end-users at very low prices. This practice, it is asserted, leads to short rental periods with the renter in a position to copy the software and thereby obtain it at bargain rates. The software vendor in this case makes only one sale, to the rental agency.

One example of such a situation is the rental company, United Computer Corp. of Culver City CA, which is engaged in a legal suit with Micropro International over just these issues. It has been reported that United Computer is considering the use of the Prolok technology, or some comparable scheme, as a guarantee to software suppliers that adequate protection is present to prevent its clients from making illegal copies. As a final example, there is the innovative solution offered by Professor Adi Shamir of the Weizmann Institute of Science located in Rehovot, Israel. Prof. Shamir is the world-renowned expert who in 1982 cracked the supposedly unbreakable Stanford-developed computer encoding scheme. The

proposed software protection technique is deemed cheap and highly effective. The basis for the process is the hardware modification of the disk drives utilized by software vendors in producing their finished product. The method would plant marginal strength pulses in selected locations in the program that would manifest themselves by non-deterministic behavior, sometimes being read as a 0 and sometimes as a 1. Personal computers are built to read weak pulses, and thus be able to cope with and execute such programs. But these computers are not equipped to introduce these weak pulses into re-recordings via the copy processes. Thus, any attempt to copy the original diskette will eliminate the weak pulses and be detectable by the subsequently executing software. The difference between the authorized software and the modified version will then be the basis for controlling the execution. The technique is also useful in presetting the number of times a program can be executed as, for example, in the case of rental or with respect to offering software on a trial basis. Each time the program is run, the user's disk drive will override a block of weak pulses with standard pulses of its own. This behavior can be employed to create a count down process which eventually uses up the preset number of executions which would be allowed.

As can be seen from these examples we are on the verge of new discovery and application of innovative techniques in the quest for protection schemes that will significantly curtail software piracy. The emergence of this new technology provides hope for the industry that innovative offerings are on their way, giving us the important economic safeguards needed to protect proprietary software rights on the one hand and the consumer on the other.



# UPGRADING APCTOAN XTRAT"

There are several different ways to add options slots and a hard disk to your PC. Here are three alternatives.

## Susan Glinert-Cole

Those of us who bought a PC back when it was the only member of the IBM microcomputer family are now often casting covetous glances at the more powerful XT. A veteran PC owner eyes the broad range of option cards wistfully, knowing that the limited number of slots precludes using more than a few of them simultaneously. Bulging boxes of floppies inevitably create an appetite for better and faster program access.

It doesn't take long to discover that floppy diskettes have numerous drawbacks. Storage capacity is limited, they can easily become lost or damaged, and programs that do a lot of diskette access can try the patience of even the most enthusiastic computer user. A hard disk is easy to

lot 18 in the XT is significantly different from the other seven option slots.

love: access time is very fast, storage capacity is large, and even the most forgetful or disorganized user has trouble losing a fixed disk. PC owners can upgrade their units in several ways, most obviously by replacing the older machine with an XT. However, this may not be the most satisfactory way to enhance your computing power. This article looks at an alternative method: an expansion chassis and an internal or external hard disk.

#### ANATOMY OF THE XT

Before comparing an XT to a PC equipped with various expansion options, we should describe the anatomy and subjective operating characteristics of an XT. The basic unit comes with one 51/4" floppy disk drive, one 10 megabyte hard disk, and a serial port. Internally, there are eight slots, two of which will accommodate only shorter boards, such as the communications and games adapters. The floppy and hard disk drive controllers take up two slots, and a smaller slot, 18, contains the communications card. This slot differs significantly from the other seven. First, the timing requirements on 18 are more stringent than those on J1-J7. Any card placed here must also generate a "card selected" signal when the card is activated. The "card selected" line (B08 in the Asynchronous Communications Adapter schematic) informs the system board that the appropriate drivers should read

from, or write to, J8. In addition, this line must be driven by an open collector device. The communications card that comes installed in the expansion chassis and the XT embodies this device in the NAND gate U6; the older communications cards do not use this line. IBM refused to speculate on the redesign of this card, saying only that it involved future plans. Open collectors allow several devices to share one line; IBM may have some interesting plans for this slot.

The addition of an IBM monochrome display/printer adapter card leaves three large slots and one small one open for other option cards. The system board has 128K (expandable to 256K), which obviates the need to use a slot for a memory card, unless more than 256K is desired.

The perceived performance of the XT is smooth and integrated. If no floppy diskette is in the drive, the system boots from the hard disk and announces its progress on the display throughout the initial memory checking procedure. This visual cue is more reassuring than the PC's display, which remains blank during this memory inspection.

Dressing a PC up to resemble an XT (at least in terms of performance) requires 128K of memory, floppy disk, 10 megabyte hard disk, communications card, monochrome display/

# Upgrading a PC

printer card, three slots, and DOS 2.0. Housing all of this in a PC would be difficult, but not impossible, given an appropriate assortment of multi-function cards. There are hard disks on the market that can be internally mounted in the PC, but there are two catches to such an arrangement. First, the power supply of the PC is insufficient to support an internal hard disk, so an external power supply is required, and second, hard disk drives from most independent vendors are not completely compatible with the IBM software and need special software drivers that are installed from a floppy diskette during initialization. These drivers must be updated for new releases of MS-DOS, and some suppliers may not provide timely service. Given the frequency with which IBM issues new versions of MS-DOS, this could mean a considerable delay in keeping the current popular version compatible with the hard disk. Hard disks that need special software to operate under MS-DOS will also need it to use other operating systems. Some manufactur-

ers ignore CP/M and the UCSD p-System, so if you use them, make sure these operating systems actually can be used with the hard disk.

Another approach to upgrading the PC is to buy an expansion unit without provision for storage, and a stand-alone hard disk. One advantage to doing this is that if the expansion unit needed service, the hard disk could still be used, given some judicious shuffling of option boards in the system unit. Also, the user is free to choose the hard disk best suited to a particular situation. On the negative side, the three units will probably occupy more desk space, add to the profusion of cables on the back of the system, and be more troublesome to service. You may have three different phone numbers to keep in mind in case of trouble, and will probably encounter dealers who invariably blame the other dealer's productnever theirs - for whatever is wrong. This can create an endless circle of finger-pointing, while your computer sits there in a state of disrepair.

A third option is to purchase an

expansion chassis with a internal hard disk. The most obvious choice here is the IBM expansion unit, but at least one other company, Tecmar, supplies such a system. Both options provide 10 megabytes of hard disk storage and five extra slots after installation of the interface boards. Both units are easy to install and use. The Tecmar unit is less expensive and more flexible than the IBM unit, but does require special device drivers from the manufacturer. The remainder of this article will explore these three options.

# THE IBM EXPANSION CHASSIS OPTION

The hardware in this package includes an expansion chassis with the hard disk and controller and receiver cards already installed, an extension card for the system unit, a cable that connects the expansion card to the receiver card, and a power cord. Outwardly, the expansion chassis unit appears identical to the PC system unit; the only difference is that a fixed disk is installed on the right

TECHNICAL SPECIFICATIONS				
	IBM Expansion Chassis	Tecmar Expansion Chassis	Apparat 10 MB Fixed Disk	IBUS Expansion Chassis
Bus:	IBM Personal Computer	IBM Personal Computer		IBM Personal Computer
Slots used:	1 in system unit; 2 of 8 in expansion unit	1 in system unit; 2 of 8 in expansion unit	One in system or expansion unit	1 in system unit 0 of six in expansion unit
Size (H $ imes$ W $ imes$ D):	$5\nu_{4''} \times 19\nu_{2''} \times 16''$	$5^{\nu_4''} \times 19^{\nu_2''} \times 16''$	$5^{\nu_4''} \times 14'' \times 11^{\nu_2''}$	$5\nu_2^{\prime\prime} \times 10^{\prime\prime} \times 15\nu_2^{\prime\prime}$
Input Voltages:	90-137 VAC @ 50/60 Hz	104-127 VAC, 60 Hz 207-253 VAC, 50 Hz	90-137 VAC @ 50/ 60 Hz	92-126 VAC, 47-440 HZ
Output Voltages:	15/A @ +5V 4.2 A @ +12 V 0.25 A @ -12V 0.3 A @ -5V	6.0 A @ +5V 6.0 A @ +12V 0.5 A @ -12V 0.25 A @ -5V	6.0 A @ +5V 2.5 A @ +12V	+5 V @ 1.5 A +5 V @ 0.5 A +12 V @ 1.5 A -12 V @ 0.5 A
Transfer rate:	0.625 Mbytes/sec	0.625 Mbytes/sec	0.625 Mbytes/sec	
Average Access Time (Msec):	85	72	85	
Cylinders:	306	306	306	-
R/W heads:	4	4	4	
RPM:	3600 +- 1%	3600 + - 1%	3600 + - 1%	4-46

hand side of the drive area.

The extender board, which is in the system unit, and the receiver card, which is in the expansion chassis, are the heart of the interface. The expansion board carries the I/O signals from the option adapters and the receiver board in the expansion unit to the appropriate processors on the system board. The receiver card coordinates data transmission in the expansion unit and sends traffic signals back to the expansion board.

All I/O channel signals from the system unit are channeled to the expansion board with the exception of the clock ("osc"). A separate clock on the expansion board generates its own signal (14.31818-MHz) and it is not necessarily in phase with the clock on the system board. The "osc" signal in the expansion chassis is used to generate the color burst signal needed for the IBM color graphics adapter, if it is in the expansion unit.

The extender card has a waitstate generator that inserts a waitstate on all memory-read and memory-write operations (except refreshing) for memory installed in the expansion chassis. A dip switch on the extender card determines the address segments that will require wait-states to be inserted during memory reads and writes. This switch actually reflects the amount of memory in the system unit and is used with the information about the total memory in the environment, as determined by the switches on the system board, to ascertain which segments reside in the expansion chassis. Wait-states cannot be inserted in segment F (hex addresses F0000 - FFFFF); this is the segment used for the ROM BIOS.

According to the documentation that accompanies the expansion chassis, all memory cards, as well as the monochrome adapter card, must be placed in the system unit. Technically, this is not true: these cards may actually reside in either unit. IBM, in keeping with their conservative philosophy, decided that the diagnostics and the memory switch settings on

the extender board would be too complex for the average user if memory and video card were not located in the main unit. One of the steps in

separate clock on the expansion board generates its own signal (14.31818-MHz) and it is not necessarily in phase with the clock on the system board.

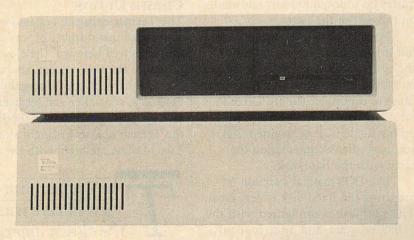
the diagnostic procedure requires detaching the expansion chassis from the system unit. Should both monitor boards be located in the expansion unit, the user would have to diagnose the problem by mental telepathy, as there would be no active display. Also, the diagnostics can't distinguish between memory in the expansion unit and memory in the main chassis. Pinpointing a memory problem would be somewhat more complicated by having memory segments divided between the two units.

The box with the documentation also contained an updated diagnostics diskette, which was floating free inside the package (not a thoughtful packaging scheme). Three pamphlets are included: an update of the prob-

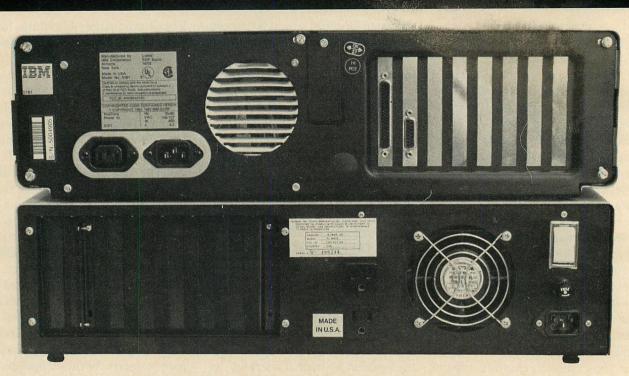
lem determination procedures for the Guide to Operations, installation instructions for the expansion unit, and a separate pamphlet on installation of the new ROM module. A plastic bag contains a bracket replacement kit for options cards because the old, wider brackets used in the PC won't fit into the expansion chassis or the XT.

The new ROM provides code that allows the system to boot from the fixed disk. The initialization code in the older ROMs checks drive A for the bootstrap. If found, the bootstrap is loaded into location 00000.7C000 and control is transferred there. Otherwise, control is transferred to cassette BASIC. The new ROMs add one more step: if no bootstrap is found in drive A, the BIOS checks for a bootstrap on the fixed disk and then transfers control to location 0000.7C000 if a bootstrap was found or to cassette BASIC if it wasn't.

The documentation is clear; there are ample line drawings to illustrate the equally clear text. The first step is to replace the ROM. This is not immediately obvious, because there is no indication as to which manual is to be read first. Once this fact had been unearthed by a careful perusal of the documentation, setup was easy. A ROM puller is provided in the ROM update package. The correct chip is removed from the U33



1. IBM/Tecmar expansion chassis—front views



2. IBM/Tecmar expansion chassis—rear views

socket on the system board and replaced with the chip sent with the expansion chassis. The expander card is installed in a system unit slot, and the cover replaced. The cable is then connected to the expander card in the system unit and the receiver card in the expansion chassis. The last step is to plug the power cord into the expansion chassis and the wall outlet. When the computer is rebooted, the hard disk is on-line. The entire installation takes less than an hour and requires no unusual tools or knowledge on the part of the user.

My PC has two floppies installed, but if there had been a hard disk in the system unit it would have had to be moved to the expansion chassis because of cabling problems. Directions for doing this are not given in the setup instructions. It is assumed that you have the documentation that came with the hard disk.

The DOS manual's section on preparing the fixed disk is very clear. The hard disk is configured with the FDISK program, and up to four partitions are permitted. Up to four operating systems (one in each of four

partitions) can reside on the fixed disk at once. If the entire disk is to be given over to MS-DOS, the disk need not be partitioned at all. In addition, FDISK will change the active partition, delete the DOS partition, display partition data, and change the default fixed disk if there are two drives in the expansion chassis. Once the disk has been formatted, the system is ready to operate.

# TECMAR EXPANSION CHASSIS OPTION

The Tecmar expansion chassis can be configured in a number of ways. The unit reviewed here was the closest approach to the IBM system: an expansion chassis with one 10 megabyte hard disk, controller and receiver card already installed. Like the IBM, the Tecmar chassis has eight slots. Two of these are filled with the drive

he Tecmar unit reviewed here was the closest approach to the IBM system.

controller and the receiver card; the extender card occupies one slot in the system unit. This results in a net gain of five slots. The photographs of the interiors of these two units illustrate an important difference between the extra slots: the Tecmar unit gains five full-sized slots, while the IBM gains four full-sized and one smaller slot. The two smaller slots in the IBM appear to have been an afterthought and were probably only meant to provide space for smaller option cards such as the IBM serial or parallel ports and the games adapter. With the profusion of multi-function boards available, it is not likely that a single slot will be wasted on a communications card. It would have been more sensible (at least from the buyer's point of view) for the IBM to have had eight full-sized slots, although the physical characteristics of the expansion chassis make this a difficult engineering feat.

Photograph 1 shows the Tecmar expansion chassis' featureless exterior. The disk drive is entirely hidden in the interior and is available in 10, 15 or 33 megabyte capacities.

Unlike the IBM fixed disk, which is designed for the single user, the Tecmar system allows shared access to the hard disk, for up to four PCs, if the individual system units are each equipped with Tecmar expansion boards. The hard disk can be divided into separate user areas. The number of user areas created is one greater than the number of users sharing the disk. All users can access a "public area" as well as an individual "private area." The shared system has a range of 40 feet: if there are two computers in the network, they can be 40 feet apart; four computers can be only 10 feet from one another. Tecmar includes a RAMDISK program in the software package (also available separately at extra cost).

The Tecmar expansion chassis busses all lines from the PC system unit, including the clock signal. Both input and output lines are buffered and no wait-states are inserted. Although the delay between the two units is short, some display interference may be noticed if video boards are in the expansion chassis. The hard disk uses a XEBEC controller.

The documentation for the Tecmar was complete, although poorly organized. Because the expansion chassis could be equipped with sev-

t took two people to attach the bracket on the Tecmar cable: one to hold the board and one to put the bracket on.

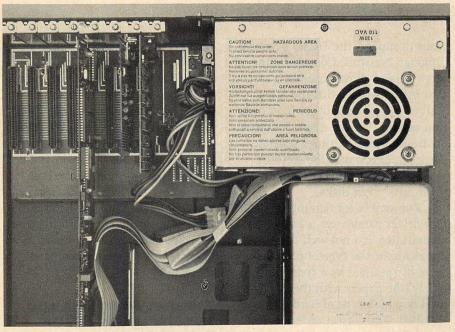
eral different kinds of hard disk drives, all of which could be set up to support up to four PCs, the instructions relevant to a particular situation were difficult to locate. Supposedly, all I had to do was install the expansion board in the system unit, plug in the power cord, and turn everything on. The actual installation was more complicated than one would have expected, given that the hard disk and receiver card were already in place. The ribbon cable that connects the expander board to the receiver board arrived with its excess length inside the expansion chassis. Pulling out a sufficient length to connect it to the board in the system unit was difficult. Once this was done and the cable was plugged into the connectors on the expansion board, a little bracket had to be clamped into position. This was also more difficult than it seemed in the instructions because the cable length prevented easy access to the board and the bracket screws were awkward to place correctly. It took two people to attach the bracket: one to hold the board and one to put the bracket on.

Setup of the hard disk itself didn't look difficult in the documentation either. It appeared merely to be a matter of running INSTALL.EXE and following the directions. Unfortunately, none of the setup and support software described in the manual was present on the floppy diskette that came with the expansion chassis. The programs which were on the diskette were not documented anywhere, and attempts

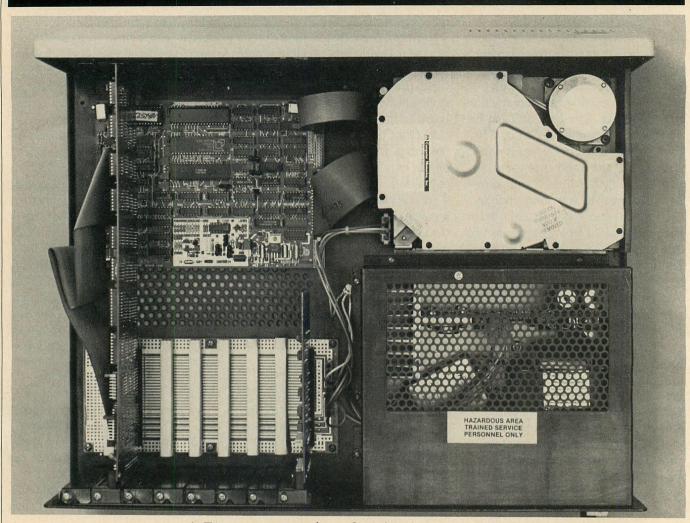
to get them running unaided were greeted with a "disk read error." It turned out that I had been shipped (1) a manual for use with DOS 1.1, and (2) a diskette with a defective driver. Replacements for both arrived promptly the following day.

The Tecmar software consists of a device driver for the hard disk, a formatting program, an initializer for placing address marks, two diagnostic routines, and a RAMDISK program. A CONFIG.SYS file must be set up on the boot disk, which names TEC-DRIVE.SYS as the device driver for the hard disk. Disk partitioning can only be done in the CONFIG.SYS file and the disk can only be partitioned in one way: half to MS-DOS and half left free for use by another operating system. Only an MS-DOS partition can be used for the multiple user areas; users cannot share access to CP/M or UCSD p-System programs.

Running operating systems other than MS-DOS on either the IBM or the Tecmar hard disk can be a problem in any case; CP/M-86 cannot run on either unit, although Tecmar is planning to offer support for concurrent CP/M. Neither IBM nor Tecmar



3. IBM expansion chassis—interior view



4. Tecmar expansion chassis-interior view

plans to support the UCSD p-System although Network Consulting Inc. offers a version of this operating system that is compatible with the XT, as well as with several other hard disks (but not the Tecmar disk). For other environments requiring a separate partition, check that the software will operate in conjunction with third-party fixed disks.

The syntax for naming the device driver parameters is needlessly complicated and not well described. For example, the type of hard disk must be specified by a code; unfortunately, the papers with the unit did not say which type of hard disk was installed. The correct code was found by trial and error.

When the system was correctly

configured and rebooted, the drive was formatted with the TECFOR program. The drive worked fine until it was rebooted; then the cursor appeared and the system hung until it was booted again. A fresh boot diskette didn't work either. I engaged in some superstitious behavior, and kept rebooting the system. Six reboots later the device driver finally installed correctly. The hard disk had somehow been totally erased during this debacle. The Tecmar unit, and its ancillary software, performed flawlessly thereafter.

## APPARAT FIXED DISK AND IBUS EXPANSION CHASSIS OPTION

The Apparat 10 MB fixed disk is

housed in an IBM PC-styled cabinet with the Winchester drive, hard disk controller, hard disk ROM BIOS and the power supply. A hardware interface board, containing the hard disk interface and a serial port, serial and fixed disk cables, hardware reference manual and software, comes with the subsystem.

No device drivers or patches are needed to have the PC boot directly from the Apparat hard disk. A PROM is provided to replace the chip in the U33 socket if the subsystem is to be connected to the older IBM 64K system board. Newer system boards that have 256K capacity do not need to have this chip replaced. (It is not necessary to have all 256K installed.)

Installation of the subsystem is a

simple matter of plugging the hardware interface board into a slot in the PC's system unit, attaching the cable and following the fixed disk setup procedure in the DOS 2.0 manual. The unit we reviewed had cosmetic flaws, but the drive worked satisfactorily during the evaluation.

The software consists of two programs: PARK.EXE prepares the Winchester drive for relocation by moving the read/write heads off of the platter, and HDFMT.APP performs a factory format on the drive. The latter program is not usually needed for installation because the fixed disk is formatted at the factory; it is primarily used when FORMAT.COM returns an error during execution. FORMAT.COM does not actually format a fixed disk-it merely verifies that the address marks are correct. If FORMAT.COM finds an illegal mark on the fixed disk, HDFMT.APP can be used to rewrite the correct format information.

The Apparat drive emulates the XT fixed disk satisfactorily with any application that uses standard DOS and BIOS calls to the fixed disk controller. It is not, however, 100 percent plug compatible with the IBM fixed disk. Apparat's approach is to make their XEBEC controller look like the IBM controller to software applica-

tions. This is done by translating bytes 1, 2 and 3 of the six-byte device control block from the unique IBM format to the industry standard format understood by the XEBEC.

All of the software we tried, with

espite the cosmetic flaws, the Apparat drive worked satisfactorily during the evaluation.

one exception, ran perfectly on the Apparat fixed disk. The exception was a local area network product that installs its own operating system on an XT. Because the network software communicates directly to the IBM disk controller, bypassing the BIOS altogether, it could not be installed on the Apparat disk. Admittedly, this is unusual, but the user must be aware of potential incompatibilities.

The IBUS expansion chassis provides six added slots for the system. IBUS buffers all signals to and from the system unit; no wait-states are used in this expansion chassis either. The IBUS unit cools by convection and therefore operates silently.

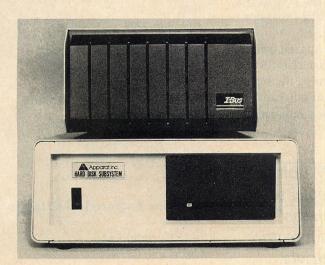
Memory, clock-calendar, asynchronous communications card and monochrome/printer adapter work fine in the IBUS. The only board we tried that would not work in the IBUS was the Apparat hard disk interface board; it had to remain in the system unit to function properly. When we talked to the manufacturer, he said that he has received several calls from Davong hard disk owners who had the same problem.

#### PROS AND CONS

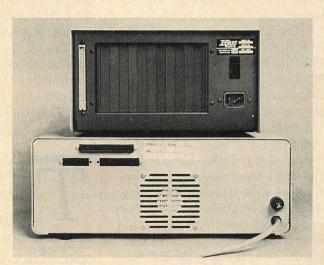
The IBM unit was far simpler to set up than the Tecmar and does not require special device drivers loaded from floppy disks. This extra step takes little time, but caused me to think of the Tecmar as "alien" hardware. If a warm reboot is performed, the driver has to be reloaded; therefore the DOS diskette must stay in the A: drive to reduce disk-shuffling.

The IBM, Tecmar and Apparat fixed disks can be backed up on floppies with MS-DOS's BACKUP and RESTORE utilities (a time-consuming process), or with non-IBM products such as a streaming tape cassette backup or with a removable cartridge unit that is compatible with either of the disk drives.

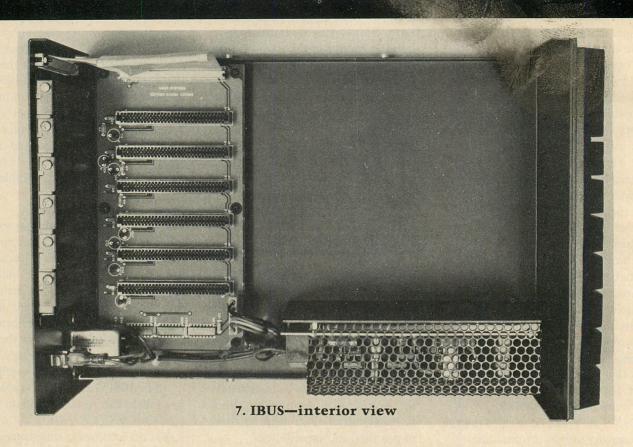
Tecmar also offers a broad range of both fixed and removable cartridge disks and there is no restriction as to where they can be placed. The ex-



5. Apparat/IBUS-front view



6. Apparat/IBUS—back view



pansion chassis is available with a single internal or separate, external hard disk, and additional drives can be installed in the system unit. Also available is a 5 megabyte removable cartridge disk drive. One or two of these can be mounted in the left side of the expansion chassis. The cartridge drives not only provide easy backup capability, but supply the system with essentially unlimited storage capacity.

The Tecmar expansion chassis with 10 megabyte hard disk is \$2795. The IBM expansion chassis, new ROM chip, and the 10 megabyte hard disk costs \$3390. IBUS sells the expansion chassis for \$695 with the 4foot cable and the Apparat hard disk costs \$1995; the total cost for the combination is \$2690. The Tecmar unit's lower cost may not compensate for the trade-offs. Operating system support is limited to MS-DOS (and possibly concurrent CP/M) and updates are at the discretion of the supplier. RAMDISK programs other than that supplied by Tecmar cannot be used, and the Tecmar version only

works with a Tecmar memory board. Utilities for the IBM fixed disk will probably not work with the Tecmar unit, and this can lock the user out of many worthwhile programs.

One other minor point is the matter of warranties. IBM and Apparat offer the standard 90-day warranty. Tecmar warrants the expansion chassis and the drive controller for one year, and the fixed disk for 90 days. IBUS covers their expansion chassis for one year.

The IBUS and Apparat combination has the advantage of software compatibility (assuming the software uses orthodox system calls) and lower cost. This makes the combination op-

he IBM unit was
far simpler to set
up than the Tecmar and does not require
special device drivers
loaded from floppy disks.

tion, multiple telephone numbers or no, extremely attractive.

#### **Apparat Fixed Disk**

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# IBM Expansion Chassis IBM

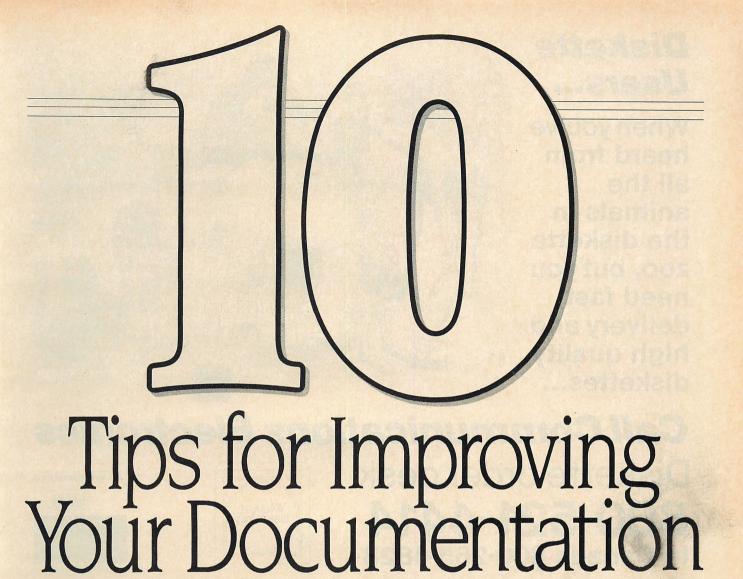
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A published writer of fiction, nonfiction, and user manuals offers some common-sense ways to take pity on the reader of documentation.

Anyone who says writing is easy is probably not writing very well. Effective communication is hard work, whether you're writing a love letter or producing a user manual. If you botch the job in either case, the results can be disastrous.

The running of your love life is not something with which I can help, but improving sales and customer satisfaction with good, usable documentation is another matter. Whether you're writing it yourself to be mimeographed in your neighbor's garage or supervising its production by 50 professional programmers, the tricks and the traps are the same. And, as a published writer of fiction, nonfiction, and user manuals, I offer here a set of ground rules for making your documentation as prideworthy

## JESSIE GUNN STEPHENS

as the software it accompanies.

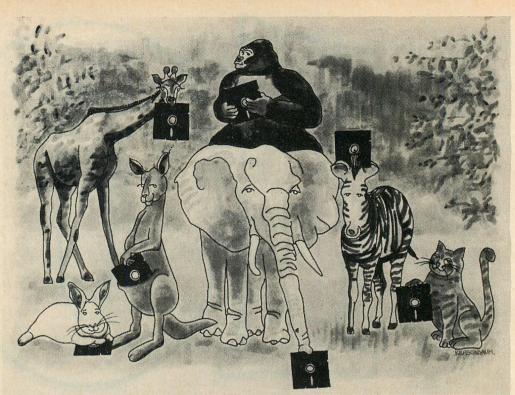
It's pointless to tell a programmer not to write jargon. A certain amount of jargon is inevitable in computer manuals. In order to talk intelligently about computer transactions, it's necessary to teach the user certain terms and phrases. Fine. But one term or phrase per element is enough, and it should be defined the first time it's used.

Perhaps the leading cause of breast-beating among lonely computer novices plowing through reams and reams of user documentation in the long dark night is the cavalier manner in which writers toss labels around. "Place the system disk in Drive A," the manual instructs. Feverishly, the user rummages through stacks of manuals and disks searching for one labeled "System Disk." He or she finally dupes out that the disk labeled "XYZ Program" is probably the same as the "System Disk." Next paragraph, the manual instructs the user to make a copy of the "Program Disk," or maybe of the "Boot Disk." Huh? Are all these disks the same or do they differ?

Have pity on the poor reader. Choose a single term to refer to each element of the system and make sure that everybody working on the project, including yourself, calls it the same thing every time. Don't let a situation develop where you refer to a "display" in one place, a "screen" the

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800-552-2211 In California 408-970-6096 next, with someone else calling it at whim a "CRT" or a "monitor." Be consistent. And if users must press "Enter" or "Return" to complete a transaction, don't forget to let them in on the secret.

To communicate effectively, writers must know their audience. Think of the manuscript as a letter being written to a specific person, someone you've never met, but about whom you know a great deal. You know, for instance, that person's relative familiarity with computer jargon. Before you write "boot the system disk," you'll ask yourself whether this person is likely to be able to accomplish that act without further instruction. If other writers are working for you, make sure you all share the same image of the reader.

By consciously choosing an audience and then visualizing a member of that audience puzzling over their written word, writers can keep jargon at the appropriate level.

Tell what more than how. It's awfully tempting once you've put together a brilliant program, tested it out, and written finis to it to want to explain to the world just how clever the little devil really is. Don't. If you're supervising the work of others, don't let this kind of self-indulgent writing slip past you. It's going to sound so good, you'll get caught up in it if you're not careful. But not only do users of an application program not care how cleverly you've utilized

he running of your love life is not something I can help you with, but improving customer satisfaction with good, usable documentation is another matter.

their expensive hardware, they may actively resent your attempt to explain your handiwork. At the prices they're paying to become part of the information revolution, they figure its brilliance ought to speak for itself.

Include practice exercises in any tutorial manual. Let the reader see the results of actions. But be sure the examples actually work. You'd be surprised at the number of "exercises" in published manuals that don't come out as they're supposed to.

t's awfully tempting, once you've put together a brilliant program, tested it out, and written finis to it to want to explain to the world just how clever the little devil really is. Don't. At the prices your customers are paying to become part of the information revolution, they figure its brilliance ought to speak for itself.

Use the imperative mode, active voice. (See? Programmers aren't the only ones who know a little jargon.) This is English-teacherese for saying, address readers directly and show someone doing something wherever possible. Instead of writing, "The program disk can now be booted," write "You can now boot the program disk."

The advantages of this style are several. First, it makes it impossible for readers to misunderstand that *they* are supposed to *do* something. Second, it's a much more immediate, more direct style, one that automatically narrows the gap between readers and the printed material in their

hands. No less important, it forces writers to think more closely about what they're telling readers to do.

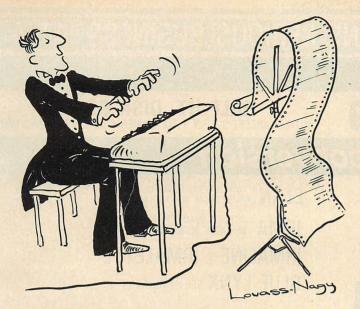
As you plan and write user manuals, work in short units. Plan sections and chapters around specific tasks, each with a beginning and an end. Allow learners to complete a task within a short period and see the results before asking them to go on to another task. For instance, if your product is a word processor, and you must teach your user all its editing functions, group related functions together into small, task-oriented lists and teach only one group in any one session. At the end of a brief session, the user should be able to say, "Now I know how to do these three specific tasks."

You'll want to keep not only the learning units short, but the words, sentences, and paragraphs as well. It's a lot easier to avoid muddling up a short sentence than a long one. It's easier to proofread it, easier to test it, easier to understand it.

As for paragraphs, be sure that each one contains a topic sentence or idea, and then include in the paragraph *only* what needs to be said to illuminate that one topic.

Short words are sometimes harder to think of than long ones. That's because we're conditioned by much we read and hear these days to think of multisyllable words as somehow more sophisticated or more learned than short ones. But it doesn't matter how "hip" the writing sounds if it ends up confusing readers or slowing them down. Many of them will have all the language problems they can handle, just learning "boot" and "file," and such. So don't burden them further by using maximize for make the most of, terminate for finish, elucidate for explain.

Each unit in the manuscript, from word to chapter, has an implicit purpose. If you stare blindly at a word, sentence, or



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paragraph and can't explain how it benefits the reader, get rid of it.

There'll be less of this kind of deadwood to prune away if you think out (or have your writers think out) objectives for each unit before writing it, evaluating what each word or group of words is supposed to accomplish. This process, called outlining, is the most reliable way of controlling the content of writing. But it's a chore, and not all programmers will find it easy. So if you are supervising writers, you may find it difficult to get them to do it. The only thing that can effectively take the place of a rigorous outline is rigorous revision of the manuscript once it's written.

Strive for professional quality in spelling, punctuation, grammar, typing, and reproduction. Professional quality in printed materials equals point-of-sale credibility. If I'm computer-illiterate, a manual written by someone who's obviously English-illiterate is not going to fill me with confidence about my ability to use the accompanying software. This point becomes more and more important as software clones proliferate. If the only difference I can see between your program and Mr. Smith's is his more businesslike manual, I'll opt for his, even if it costs a little more. I will have more confidence in his product simply because it looks more professional.

If you have the resources, this is the time to call in a technical writer or editor. If you work in a sizable firm, maybe you can borrow someone with the expertise from somebody else's staff. Otherwise look in the phone book under "Employment Contractors—Temporary" or "Technical Manual Preparation," to find a contracting firm that specializes in user manuals. Or you might get in touch with the local chapter of the Society for Technical Communication and ask them to recommend someone in your area. If your project is relatively small and your budget

won't handle a consulting contract, you still can't afford to slight this phase of production. Surely you know an English teacher who might lend aid with these matters (for pay, of course; technical editing fees start at about \$15 an hour, without involving major rewriting).

When all else is said and done, proofread. Take this task on yourself. Whether you wrote the program yourself or the boss delegated responsibility for the manual to you from

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however new and
small, however
powerful in the marketplace, can afford to let an
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on high makes no difference. It's your baby. No one else is as well equipped to do this kind of quality control; no one else cares as much about the final product as you do.

Provide an index. Better yet, provide both an index and a quick reference card, or at least a list of the program's functions and options, showing where each is located in the manual.

As obvious as this advice sounds to anyone who has ever tried to use a 300-page tutorial manual as a reference guide, we're still seeing the production of enormous books with inadequate indexes, or—and I cringe—no indexes at all. Personally, I refuse to buy a program accompanied by an indexless manual. It won't be long

before the rest of the buying public joins me in this eminently reasonable stand.

No operation, however new and small, however powerful in the marketplace, can afford to let an untested document accompany its products. Once you think the manuscript is complete, let someone read it who had absolutely no part in generating it. Avoid, at all costs, drafting a programmer for this job. Call someone in from another department, or off the street, if you have to, to find an objective reader. And listen carefully to what they have to say. If they can also try to run the program using the document (with no verbal help from you), you'll learn a great deal about how effectively the thing communicates. Then, don't be afraid to revise.

There's no such thing as a perfect first draft. You may not like doing it, your programmers won't like doing it, but all good writers revise as a rule, sometimes extensively. After all, you revise software when necessary, don't you?

Jessie Gunn Stephens is a freelance writer in Sherman, TX, whose work has appeared in a number of computer-related magazines.



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# Dan Illowsky and Michael Abrash

Reading IBM Game Adapter inputs using assembly language

Part I of this article (PC TECH JOURNAL, January 1984), started with an overview of Game Adapter hardware and operation and covered possible applications. Also discussed were various ways to monitor the Game Adapter state from BASIC, with an illustrative program and a sample application. Part II, which follows, covers reading the Game Adapter inputs using assembly language.

## ADVANCED JOYSTICK STATEMENTS

Advanced BASIC provides two powerful joystick statements in addition to those in standard BASIC. These statements, ON STRIG and STRIG(n), work together to provide excellent response to joystick buttons.

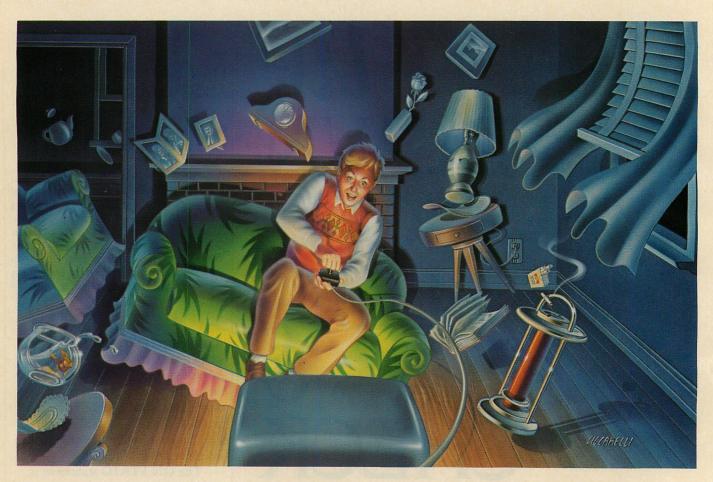
The ON STRIG statement is

#### ON STRIG(n) GOSUB line

where n is 0, 2, 4, or 6, as with the STRIG function. Zero means button 1 on joystick A, 2 means button 1 on joystick B, 4 means button 2 on joystick A, and 6 means button 2 on joystick B. An ON STRIG(n) statement tells BASIC that whenever the specified button is depressed, the program

Don Illowsky and Michael Abrash are officers of Funtastic Inc., a software publishing house located near Philadelphia. They are the authors of Snack Attack, County Fair, Cosmic Crusader, and Big Top for the IBM PC and Apple II.

# GAME ADAPTER



should GOSUB (or trap) to the program line specified by *line*. The section of the program that is trapped should be a subroutine, terminated with a RETURN statement. If *line* is 0, then the button is not trapped; the specified ON STRIG has no effect.

The great advantage of trapping is that there is no need to keep checking the state of the buttons (polling); the proper subroutine is executed automatically whenever a button is pressed.

The STRIG(n) statement enables, disables, or suspends trapping of the button specified by n, where n is the same as the ON STRIG statement. The statement

## STRIG(n) ON

must be executed before the ON STRIG(n) statement can trap the button specified by n. (STRIG ON must also be executed; programs that use the joystick buttons should always execute a STRIG ON at the start.)

The statement

#### STRIG(n) OFF

disables trapping of the button specified by n. If the specified button is

here is one important consideration with the ON STRIG and STRIG(n) statements: the times at which trapping is allowed must be carefully thought out.

pressed after a STRIG(n) OFF, the button is simply ignored.

The statement

#### STRIG(n) STOP

suspends trapping of the specified button. However, BASIC remembers if a button is pressed while the STOP is in effect. When the specified button is reenabled with a STRIG(n) ON statement, a trap to the line specified in the corresponding ON STRIG

statement immediately takes place if the button has been pressed.

Through the STRIG(n) and ON STRIG statements, a program can respond to joystick buttons without ever having to check explicitly whether the buttons are pressed. Also, during critical parts of the program, trapping can be either halted or suspended for later processing.

The times at which trapping is allowed must be carefully thought out. For example, BASIC checks the joystick buttons before it executes each command. If a trap could occur at any time, a button could be held down, and BASIC would logically trap during the trap routine itself, setting up a sort of infinite loop. Not surprisingly, this possibility has been taken care of. When a trap occurs, a corresponding STRIG(n) OFF is automatically performed by BASIC. Then, when the RETURN from BA-SIC is executed, trapping of the button is automatically turned back on, unless a STRIG(n) OFF is explicitly



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# GAME ADAPTER

executed in the trap routine.

There are circumstances under which the programmer must disable trapping. For example, suppose that in a game, a spaceship is redrawn in its current location every time a button is pushed. If a series of calculations determines the location of the spaceship, it is imperative that these

calculations be finished before the ship is drawn; otherwise the space-ship will be drawn at a location where it never really was, determined partially by the old coordinates and partially by the unfinished calculations for the new location.

The following program example illustrates this concept further. Basi-

cally, the idea is that under some circumstances, the actions set in motion by the joystick button and the ON STRIG statement can interact with ongoing operations to produce incorrect results. Using STRIG(n) STOP, the response to pressing a button can be deferred until trapping can proceed safely. Incidentally, assembly language programmers will recognize this situation as that which occurs with interrupts, where the program must be free to run uninterrupted at certain times. We will encounter interrupts again later in this article.

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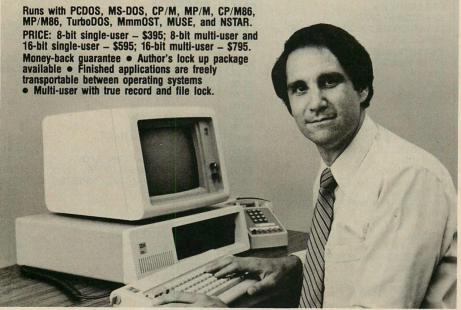
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## A JOYSTICK-DRIVEN DRAWING PROGRAM

The program shown in listing 1 integrates the joystick commands we've covered in a simple drawing program that allows the user to turn on or off any block in a 5 X 7 grid, controlling all action from joystick A. Such a program could, for example, be useful for designing characters. Only the joystick-related portions of this program are explained below.

Line 180 enables the joystick buttons with STRIG ON.

Lines 190-220 calibrate the joystick. The user is requested to center the joystick and strike the Enter key. The x and y readings of the centered joystick are then taken.

The grid in which the drawing takes place consists of 7 vertical segments and 5 horizontal segments. A scaling factor is needed that relates each joystick position to a specific grid location. In the x direction, there are 5 columns: one-third of the centered x value is taken as the interval between columns. Thus, an x value that is the centered value would indicate column 3, which is where the user wants the cursor to appear when the joystick is centered. Each move of one-third of the centered value from this center point in either direction would cause the cursor to move one column in the indicated direction. The y increment between rows is one-fifth of the centered y value, so the cursor centers on row 5.

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Line 310 enables trapping of both buttons on joystick A. Button number 1 traps to line 510, where the spot pointed to by the cursor is made white. Button number 2 traps to line 520, where the spot pointed to by the cursor is made black.

Lines 320-490 constitute the main program loop. First, trapping of joystick buttons is suspended with STRIG(n) STOP statements on line 330. Then line 340 obtains the current joystick location. Lines 350 through 450 then calculate the new cursor location, based on the location of the joystick handle. As discussed above, the cursor coordinates are only partially calculated while these lines are executing, and are therefore not correct. This is why trapping must be suspended while these calculations are made. It is not until line 470 that trapping of the buttons can safely be allowed again. Line 490 then repeats the loop unless a key has been struck, in which case the program ends.

An important technique is used on line 360. As mentioned previously, there can be some random fluctuation in the joystick reading even if the joystick is still. Further, the program user is likely to jitter the handle a bit while holding it. To compensate for this, the program does not act on any change unless there is a change of at least 5 in either the x or y coordinate from the reading that was the basis for setting the current cursor location. Line 360 skips the entire calculation section if the change did not reach the threshold level.

Lines 400, 410, 430, and 440 illustrate another important concept. The scaling factors set earlier work well under most conditions, but at the extremes, where the joystick is fully to the right or left, the values returned might not be usable if the proper checks are not inserted. For instance, if the joystick is to the far left, a very low number could be returned, setting XLOC% to 0, which

would place the cursor off the grid. Always try to think of all the exceptional conditions that could foul up a program, and then insert the proper safeguards. In listing 1, this means that out-of-range values are simply converted to the nearest valid value.

# How It Works—A TECHNICAL DISCUSSION

BASIC makes using the Game Adapter easy. However, considerably more information is required to use the Game Adapter from assembly language. A detailed knowledge of the adapter, as well as a good understanding of the 8088 microprocessor, is necessary. However, assembly language also allows more flexible and accurate readings to be taken.

Both hardware and software are necessary to convert the external resistance attached to the Game Adapter into a usable number. When software sends a triggering signal to the adapter, the adapter responds by setting one bit high (equal to 1) at an input port for a period proportional to each resistance attached. The length of these high pulses must be measured by software. This is done by performing a loop of known length until the pulses of interest go low (become equal to 0); counting the number of times the loop has been executed measures the resistance.

The triggering action is an OUT to port 201H (hexadecimal; this is equivalent to 513 in decimal). The pulses, as well as the buttons, can be monitored at port 201H. The assignment of the bits at port 201H is shown in figure 1. As shown in figure 2, the OUT 201H initiates the pulses that measure the attached resistances. Assume that we are talking only about measuring the resistance of the x coordinate of joystick A, so that we are interested in bit 0 of port 201H only. Once the OUT 201H is executed, we want to know how long bit 0 at this port means equal to 1. This can be done by a loop like

MOV DX,201H MOV BL.1

Figure 1: Bit assignments at port 201 (hexadecimal)

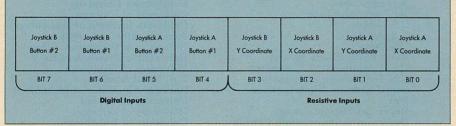


Figure 2: High pulses proportional to the resistances attached are put out by the Game Adapter at bits 0-3 of port 201 (hexadecimal). The pulses are triggered with an OUT to port 201H.

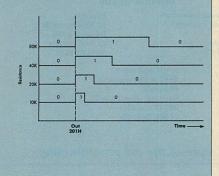
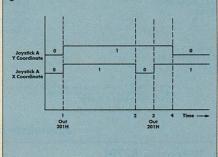


Figure 3: If pulses are read too close together, errors may result because a high pulse will not retrigger. Here, the Y coordinate has not yet finished the initial pulse when retriggering occurs, so that only the portion of the pulse between points 3 and 4 is measured.



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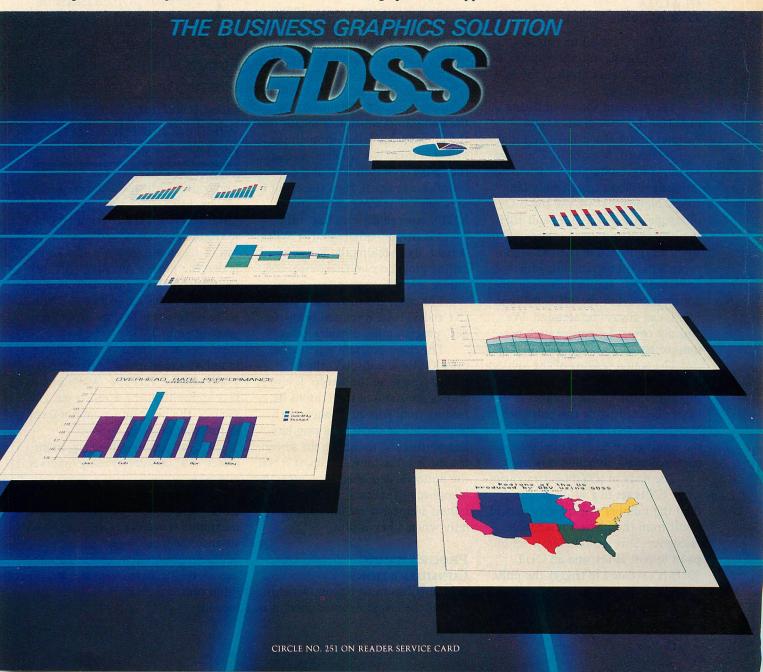
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# GAME ADAPTER

LOOP:
IN AL,DX
TEST AL,BL
JE DONE
INC SI
LOOP NEXT
DONE:

Register SI will contain the count of number of times through the loop when the pulse goes low.

The digital inputs can be monitored simply by performing an IN from port 201H and checking the appropriate bit, as shown in figure 1. For example, to check button 1 of joystick A, one would execute

### MOV DX,201H IN AL,DX TEST AL,10H

If the Z flag were set by this sequence, then the button would be depressed; if it was reset, then the button would be up.

The program shown in listing 2 monitors the state of the Game Adapter inputs. Each resistive input is read in turn. Most of this program performs screen output, which is notoriously difficult in assembly language. Notice that we use the BIOS interrupts (interrupts 16H and 10H, the keyboard and video interrupts, respectively) instead of the DOS interrupts. This is because with games and protected software, DOS is sometimes not available, but the BIOS, being in ROM, can always be accessed. We will not cover the non-joystick portions of assembly language programs.

The actual reading of the joystick is performed in PROC JOYIN. This subroutine counts the number of loops executed while the pulse is high; as the loop is a fixed length, the count given in SI is directly proportional to the attached resistance.

The body of JOYIN is straightforward. CX is set to a value greater than the number of loops that would result from the highest reasonable resistance. SI is set to 0. DX is set to point to port 201H, and an OUT 201H is executed to trigger the pulse.

The following statements perform the actual counting. The IN

statement gets the Game Adapter information from port 201H. The byte from port 201H is then tested to see whether the pulse is still high. If the pulse has gone low, the loop terminates by branching to label DONE: If it is still high, the count is incremented, and the program loops back to label NEXT: to check the Game Adapter and count again.

If CX loops down to 0, the program falls out of the counting loop. Since CX was set to a number greater than the maximum count at the beginning, if it is counted down to 0 then either there is something wrong with the adapter, the attached resistance is too high, or there is no device attached to the resistive input being monitored. The falling out of the loop based on the maximum value prevents the program from getting stuck in an infinite loop.

Finally, the count stored in SI is compared to the maximum count. If the two counts equal, this means that the program has fallen through the loop and there is a problem, so that the count in SI is invalid; if the two counts are unequal, then the count in SI is valid. The CMP at the end of JOYIN sets the Z (zero) flag if the count is invalid; otherwise the Z flag is reset. By checking the Z flag, the calling program can detect error conditions and take appropriate action.

The other instructions in JOYIN, CLI and STI, are discussed below under "programming considerations."

The main program repeatedly calls JOYIN and displays the returned counts on the screen. It also checks the status of the buttons by reading from port 201H once, then testing each of the four button bits and putting the results on the screen. If a bit is 1, the button is up; if it is 0, the button is depressed. The program loops back to check and display the button and resistance inputs, ending only when a key is hit.

# PROGRAMMING CONSIDERATIONS

Several points must be considered in reading the Game Adapter. First, it is

important that readings not be taken too close together, especially when each input is read separately. For example, suppose that the x coordinate of joystick A is counted, followed by the y coordinate. When the OUT 201H is executed to start the pulse for the x coordinate, it also starts the other three pulses. Suppose that the resistance in the y direction is considerably greater than in the x direction so that the y pulse will be much longer than the x pulse. The situation depicted in figure 3 then occurs.

Both pulses go high when the OUT 201H occurs (point 1). The pro-

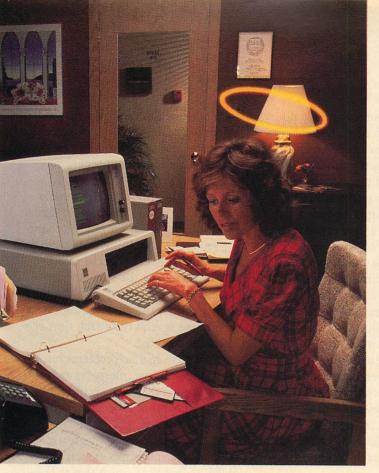
everal points must be considered in reading the Game Adapter.

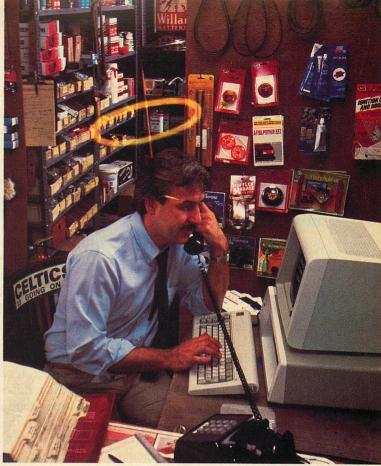
First, it is important that readings not be taken too close together, especially when each input will be read separately.

gam counts until the x pulse goes low (point 2). Then the program performs another OUT 201H, intended to trigger the y pulse so that it too can be measured (point 3). The catch is that if a pulse is already high when the OUT 201H occurs, there is no triggering effect; consequently, the y pulse merely finishes the time triggered at point 1. When the pulse then goes low after a very short time (point 4), the program thinks that the y resistance is very low, when in fact it is higher than the x resistance. Obviously, the program would not seem to function properly.

The minimum safe delay, in microseconds, between reading inputs is given by

Minimum safe delay = 24.2 + 0.011 \* maximum resistance where maximum resistance is the highest resistance the joystick can achieve. 300K ohms would be a safe figure to use for PC joysticks, resulting in a minimum safe delay of 3.325 microseconds.





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# GAME ADAPTER

The program in listing 2 calls PROC DELAY to pause between joystick reads. This subroutine takes about 65,000 cycles to execute, or about 13,700 microseconds, well in excess of the minumum safe delay. If

#### MOV CX,OFOO

in PROC DELAY was changed to

#### MOV CX,0400

then the delay would be near the minimum safe value.

The simplest solution to the minimum safe delay problem is to ensure that each reading takes at least the maximum that a pulse could possibly take. The program in listing 3, to be discussed in detail below, does just this. No matter what the length of the pulses, the joystick routine in listing 5 always takes the same amount of time to execute, and since that length of time is greater than the minimum safe delay, no overlap between readings is possible.

The resistance inputs, being analog readings, are subject to slight random variation when converted to digital values by the Game Adapter. A reading could be on the edge between two values, and could return either one. For this reason, programs should never result to count variations of only 1. For human input, a minimum change, such as that in listing 1, should be required. When running the program in listing 2, try to hold the joystick still and notice that the numbers displayed vary markedly.

The digital inputs are not debounced. This means that when a button is depressed it may hit bottom, bounce a bit, and return a sequence of up/down values before it settles down. Switch closure can function similarly. Users who have software that responds rapidly to the digital inputs may want to take several readings to be sure of the button or switch state.

A final and equally critical consideration in reading the joystick involves the fact that the PC functions by interrupts, which break in on

whatever program is running, do what has to be done, and then allow the program to proceed. An example of an interrupt is the timer in the PC which keeps the clock running; approximately every 55 milliseconds, the timer interrupt suspends whatever is going on and executes a routine that counts off another clock tick, maintaining the time and date.

The time consumed by interrupts is generally short, but can cause some variation in the count returned by the pulse-counting routine. If an unusual device, which requires the execution of a lengthy interrupt-handling routine, were attached to the PC, the results reported by the pulse-counting routines could be skewed. To forestall this problem, a CLI is executed at the beginning of the JOYIN subroutine to disable all interrupts

final and equally critical consideration in reading the joystick involves the fact that the PC functions by interrupts, which break in on whatever program is running, do what has to be done, and then allow the program to proceed.

for the duration of the count. An STI must be executed at the end of the subroutine, or the PC will no longer respond to the keyboard and will have to be rebooted. Disabling interrupts insures that each pass through the counting loop will take precisely the same amount of time, thus providing a reliable counting base.

On the other hand, disabling interrupts also can interfere with other devices on the PC. When CLI is executed to disable interrupts, any incoming interrupts are forced to wait until STI is executed to reenable interrupts. This is no problem so long as no single interrupt occurs more

than once while interrupts are disabled. For example, our joystick routine takes less than 4 milliseconds, and the timer interrupt occurs only once about every 50 milliseconds; therefore, the timer interrupt could not possibly occur twice during the counting loop. If, however, the counting loop took 200 milliseconds, the timer interrupt could occur four or five times during the loop, and all but the last occurrence would be lost. Consequently, the clock on the PC would lose several ticks each time the loop was executed.

We have had no problems resulting from disabling interrupts and know of no published specification for the maximum time interrupts can be disabled on the PC. On the other hand, there are usually no great variations when interrupts are left enabled, so it is not critical that they be disabled. In our opinion, the most accurate approach is to disable interrupts while counting.

# READING ALL FOUR RESISTIVE INPUTS AT ONCE

The program shown in listing 3 reads all four resistive inputs in one loop. The loop always takes the same amount of time to execute. This gets rid of the minimum delay problems, and is faster than reading each input separately. However, the counts returned by this loop are considerably lower than those returned by the individual counting loop, because more must be done in the loop, taking more time. When you run this program, compare these counts with those from the program in listing 2.

The problem of getting high enough joystick counts is presumably why some manufacturers use resistances far in excess of the standard 100K ohms on the PC. The higher the resistance, the longer the pulse and the higher the count.

All four resistive inputs are read at once in PROC JOYIN, as shown in listing 3. As with the program in listing 2, interrupts are disabled, the maximum count is set, DX is set to

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# GAME ADAPTER

the Game Adapter port, and the count registers SI and DI are set to 0. Registers BP and BX are set to 101H; each bit that is on indicates that the pulse from one of the resistive inputs is still high and should be counted.

The body of this loop is somewhat complicated. The Game Adapter byte is read into AL from port 201H and copied into AH as well. The y coordinate of joystick A is shifted into the low bit of AH; the x coordinate or joystick A is already in the low bit of AL. AX is then ANDed with BP: if either of the coordinates of joystick A has gone low, then the corresponding bit of BP will become 0, and that coordinate will cease to be counted. Otherwise, the bit in BP will stay high and the coordinate will continue to be incremented. The count is accomplished when BP is added to SI; if either bit of BP is 1, then the corresponding half of SI will be incremented.

Similarly, the joystick B bits are shifted into the lower bits of AH and AL, ANDed with BX, and added to DI. This loop is repeated 255 times.

The counts are stored in each half of SI and DI, as shown in figure 4. That is, the x coordinate of joystick A is stored on the lower 8 bits of SI snd the y coordinate is stored in the upper 8 bits. Joystick B readings are similarly stored in DI. Clearly, this scheme only works so long as the count cannot exceed 255; but we can in fact only execute the loop a maximum of 255 times, since this is the value of MAX\_COUNT. This does not create any problems since not

even a 300K ohm resistance will cause a count as high as 255.

The loop can never be executed less than 255 times either; it will always take precisely the same amount of time to execute this routine, whatever the pulse lengths are. This can be important in making a program run at a constant speed.

JOYIN finishes up by transferring the counts to AX and BX, where they can be manipulated more easily, since these registers can also be treated as 8-bit register pairs. Finally, interrupts are enabled.

This routine takes less time than four separate loops that read one input each. The only limitation with this routine is that because the loop does not execute as fast as a single-input loop, such as the one shown in listing 2, the range of values returned is relatively small. The higher the count number produced by a loop for a given resistance (that is, the faster the loop executes), the more precise the number returned and the greater the range of available values. This can become important at low resistances and in distinguishing between many joystick locations. For example, if the range of values returned is 1 to 40, then 40 joystick locations (at the most) can be distinguished. A faster loop might allow a range of 1 to 200, allowing five times as many joystick locations to be distinguished. Singleinput counting loops are faster than multiple-input loops, and they are preferred when the precision with which the joystick location is specified is important.

It is not necessary that all four inputs be read. If you were only interested in the joystick A inputs, for instance, PROC JOYIN in listing 3 could be speeded up by leaving out the four lines

SHR AX,1 SHR AX,1 AND BX,AX ADD DI,BX.

Ready to test your joystick and assembly language programming skills? Try writing a loop that executes more rapidly than the one shown in listing 3. Remember, the tighter the loop, the more precise the results.

#### **COUNTING CYCLES**

In order to use the Game Adapter, it is not necessary that you know how long the pulse actually is: everything can be made relative by proper calibration, as was shown in listings 2 and 3 published in Part I of this article. But to what resistance does the count actually correspond? Such knowledge can be useful in design situations. Assume we are using the following code for our timing loop:

MOV DX,201H
MOV BL,1
LOOP:
IN AL,DX
TEST AL,BL
JE DONE
INC SI
LOOP NEXT
DONE:

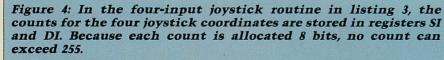
The *Technical Reference* manual gives the following formula for converting resistance into time:

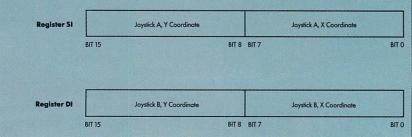
Count time = 24.2 + 0.011 \* resistance

so the formula for converting time into resistance is this:

Resistance = (count time -24.2) / 0.011

where all times are in microseconds and all resistances are in ohms. Then, to convert time into passes through the loop, we must determine the number of computer cycles executed each time through the loop. According to the individual times required





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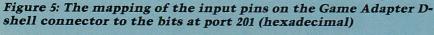


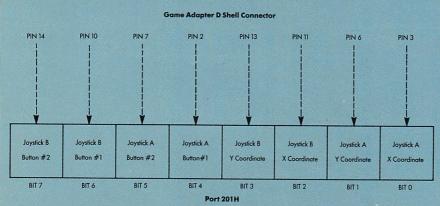
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to execute the instructions in the loop shown above, the loop should take 34 cycles per pass, with the PC executing 4.77 million cycles per second. Assuming that this figure is correct, experimentation indicates that the above formula is wrong. However, counting cycles on the PC has a complication that we have not seen documented anywhere.

Each byte of each instruction must be fetched from memory. Given the speed of the PC's memory, this requires four cycles per byte. Some of the instructions in our loop take less than four cycles; for example, INC SI requires only two cycles. However, the processor must then wait around until the next instruction is fetched. If we assume that all instructions take four cycles per byte, the formula given by the Technical Reference manual is a close approximation. Unfortunately, timing calculations also depend on the state of the instruction prefetch queue, and are difficult to work out precisely.

The moral is that you may not get an accurate count of cycles by using the published instruction execution times. Unfortunately, determining the exact speed of execution of assembly language can be very difficult. If you string together a number of very fast instructions, such as INC, SHL, ROR, and most register-register instructions, your code may not execute as rapidly as you might think it does.

At any rate, with a figure in hand for cycles per loop—in this case 45—we know how many microseconds the loop takes. Here, one loop equals 45 \* 1/4.77 microseconds, or about 9.4 microseconds. Multiply the loop count by 9.4 to get the length of the pulse; the formula for converting time into resistance can be used to calculate the resistance attached.

### CONNECTING TO THE GAME ADAPTER

To attach homemade joysticks or other devices to the Game Adapter, use the D shell connector. The pin assignments for this connector are shown in table 1.

Resistances are connected between +5 volts (any of pins 1, 8, 9, or 15) and one of the four resistance inputs (pins 3, 6, 11, and 13). Pins 3 and 6 are generally used for the x and y inputs, respectively, from joystick A, and pins 11 and 13 are generally used for the x and y inputs, respectively, from joystick B. It is a good idea to keep any resistances attached between 0 and 250K ohms.

Switches are connected between ground (any of pins 4, 5, or 12) and one of the four digital inputs (pins 2, 7, 10, and 14). Generally, pins 2 and 7 are used for the button inputs from joystick A, and pins 10 and 14 are used for those from joystick B.

Mapping of resistance and digital input pins to the bits in the byte at port 201H is shown in figure 5.

#### CONCLUSION

The Game Adapter is a simple, flexible interface to the external world. used mostly for games but applicable to some other uses as well. To use the joystick from BASIC, you must know how to calibrate for the varying joysticks available, how to avoid random jitter, and under what conditions STRIG(n) STOP must be used. In assembly language, you must avoid reading the inputs at too short an interval, disable interrupts, debounce the switches, and perform the same human engineering, such as calibration, that must be done from BASIC. The Game Adapter is one of the simplest hardware devices in the PC: still, intelligent, well-conceived software is required to use it properly.

Table 1: Pin assignments on the Game Adapter. Connections are made through a 15pin, D-shell connector at the back of the PC.

PIN	ASSIGNMENT
1	± 5 Volte

2 Joystick A, Button #1

3 Joystick A, X Coordinate

4 Ground

5 Ground

6 Joystick A, Y Coordinate

7 Joystick A, Button #2

8 + 5 Volts

9 + 5 Volts

10 Joystick B, Button #1

11 Joystick B, X Coordinate

12 Ground

13 Joystick B, Y Coordinate

14 Joystick B, Button #2

15 + 5 Volts

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#### LISTING 1: BASICA STATEMENTS FOR USING A JOYSTICK ATTACHED TO THE GAME ADAPTER CARD

100 REM This is a program used to draw pictures 110 REM in a 5 column by 7 row grid. This program serves as an example of 120 REM 130 REM the BASICA statements for using 140 REM a joystick attached to the Game Adapter 150 REM Card. 160 REM 170 CLS:SCREEN 0:WIDTH 80:KEY OFF 'Set up screen 180 STRIG ON 'Allow the trapping of joystick buttons 190 REM Calibrate so any manufacturer's joystick may be used 200 PRINT "Center your joystick and press ENTER" 210 JAX%=STICK(0):JAY%=STICK(1):IF INKEY\$="" GOTO 210 220 XSCALE=JAX%/3:YSCALE=JAY%/5 'find scale factors 230 REM Put grid on screen 240 CLS 250 FOR I=1 TO 7:LOCATE 10+1,34:PRINT I:NEXT I 260 LOCATE 10,36:PRINT "12345" 270 FOR I=11 TO 17:FOR J=36 TO 40:LOCATE I,J:PRINT CHR\$(249):NEXT J:NEXT I 280 REM Initialize old values so that first reading will be a change 290 OLDX%=100:OLDY=100 300 REM Subroutines will be called when buttons are hit 310 ON STRIG(0) GOSUB 510:ON STRIG(4) GOSUB 530 320 REM Trapping must be turned off until locations are fully calculated 330 STRIG(0) STOP:STRIG(4) STOP 'Get joystick readings 340 JAX%=STICK(0): JAY%=STICK(1) 350 REM Prevent jittering of cursor 360 IF ABS(OLDX%-JAX%) < 5 AND ABS(OLDY%-JAY%) < 5 GOTO 450 370 OLDX%=JAX%:OLDY%=JAY% 'Reset old values 380 REM Determine the relative cursor locations 390 XLOC%= JAX%/XSCALE 400 IF XLOC%<1 THEN XLOC%=1'Keep location in range

420 YLOC%= JAY%/YSCALE
430 IF YLOC%=1 THEN YLOC%=1
440 IF YLOC%=7 THEN YLOC%=7
450 LOCATE YLOC%=10,XLOC%=35,1'Set the new cursor location
460 REM Allow trapping of buttons again
470 STRIG(0) ON:STRIG(4) ON
480 REM If no key has been pressed, keep going
490 IF INKEY\$=""GOTO 320
500 END
510 REM Fill in spot pointed to by joystick in grid
520 LOCATE YLOC%=10,XLOC%=35:PRINT CHR\$(177):RETURN
530 REM Put grid mark in spot pointed to by joystick
540 LOCATE YLOC%=10,XLOC%=35:PRINT CHR\$(249):RETURN

#### LISTING 2: CONTINUOUS DISPLAY OF THE STATE OF ALL INPUTS ON THE GAME ADAPTER CARD

segment para stack 'stack 64 dup ('stack ') db stack ends segment para public 'code' code assume cs:code,ds:data,es:nothing ; THIS PROGRAM CONTINUALLY DISPLAYS THE STATE OF ALL THE INPUTS ON THE GAME ADAPTER CARD ; (RETURNS TO DOS WHEN KEY IS PRESSED) showjoy proc far ; SET FOR RETURN TO DOS push ds xor ax,ax push ax

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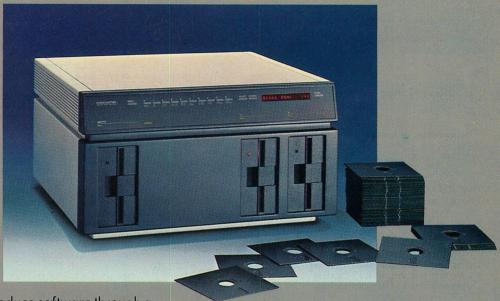
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### GAME ADAPTER

```
; SET DATA SEGMENT
         mov
                 ax,data
         mov
                ds,ax
 ; CLEAR SCREEN
         mov
                cx,48 ;100p 48 times
 clear loop:
         push
                         ;save counter
         mov
                ah,14
                        ;BIOS print character function
         mov
                 a1,10
                        ; char to print is line feed
         mov
                 b1,3
                         ; character color if we are in
                         ; graphics mode
         mov
                 bh,0
                        ;display page 0 if we are in
                         ; text mode
         int
                 10h ;call BIOS print function to print
                        ; line feed. After 48 times,
                        ; the screen will be clear
                        ;get counter back
         100p
                clear loop
                             ;do next line feed
 ; DISPLAY LABELS
                si, offset labstg
         call
               showtxt
 ; READ INPUTS FROM GAME CONTROL ADAPTER
 read again:
        mov
                                ;set to read JAX
         call.
                joyin
                                ;get reading
        mov
                di,offset jax ;prepare for printing
        call
                mkstg
                                ; result
        call
                delay
        mov
                bx,2
                                ;set to read JAY
        call
                joyin
                                ;get reading
        mov
                di,offset jay
                                ;prepare for printing
        call
                mkstq
                                ; result
        call
                delay
                bx,4
                                ;set to read JBX
        call
                joyin
                             ;get reading
                di, offset jbx ; prepare for printing
        call
                mkstq
                                ; result
        call
        mov
                bx.8
                                ;set to read JBY
                joyin
        call
                               ;get reading
                di,offset jby ;prepare for printing
        mov
        call
                mkstg
                               : result
        call
                delay
        in
                al,dx
                               ;get button bits
                di,offset jal ;place for string
        mov
        test
                a1,10h
                               ;test button JA1
        call
                updown
                               ;put in string
                di,offset ja2
                               ;place to put string
        test
                a1,20h
                               ;test button JA2
        call
                               ;put in string
                di,offset jb1 ;place to put string
        mov
                a1,40h
        test
                               ;test button JB1
                               ;put in string
        call
                updown
        mov
                di,offset jb2
                               ;place to put string
        test
                a1.80h
                               ;test button JB2
        call
               updown
                               ;put in string
; PRINT ALL THE VALUES ON THE SCREEN
        mov
               si, offset valstg
        call
                showtxt
                               ;put values on screen
: TEST FOR KEY PRESS
       mov
               ah 1
                               ; if a key has not
        int
               16h
                              ; been hit then
                                  do it again
        iz
               read again
        mov
               ah,0
                               ; else get the key
        int
               16h
        ret
                               ; and return to DOS
showjoy endp
; CONVERT JOYSTICK VALUE IN SI TO STRING
   FOR PRINTING
mkstg proc near
        ie
               error
                               ;joystick not attached
       mov
               cx,4
                               ;four characters to be made
```

```
mov
                bx,si
                               :save all values
                si,bx
                               remaining digits
                si,Ofh
        and
                               ;isolate next digit
                al,[si+chtbl] ;find character for digit
        mov
                               ;put character in string
        mov
                [di+3].a1
        dec
                di
                                ;next character goes to left
        shr
                bx.1
                                ;position next digit
        shr
                bx.1
                                ; for conversion to a
        shr
                bx.1
                                ; character for printing
        shr
                bx.1
        100p
                nxch
                                :go to do next character
 :
        ret
                               ;finished with all four digits
error:
               word ptr [di+2], "A/" ;not available
        mov
        mov
                word ptr [di],"N "
                               ;finished
        ret
mksta endo
.
; CONVERT EQUAL FLAG STATUS TO 'ON' OR 'OFF' STRING
 updown proc
               near
        ie
                down
                                       ; if bit is zero
                word ptr [di], 'PU'
        mov
                                       ; if bit is one
                word ptr [di+2],' '
                                       ; then button
        mov
        ret
                                       ; is up
down:
        mov
                word ptr [di],'00'
                                       ;button is down
                word ptr [di+2],'NW'
        mov
        ret
updown endp
; DELAY SO THAT READINGS DON'T INTERFERE WITH
; EACH OTHER
delay proc near
               cx,0f00h
        mov
here: loop
delay endp
; THIS ROUTINE READS A RESISTIVE INPUT
   FROM THE GAME ADAPTER CARD
                BL - MASK FOR INPUT BIT
                    1 FOR JAX
                      4 FOR JBX
                      8 FOR JBY
       OUTPUT
               SI - VALUE PROPORTIONAL TO
                   RESISTANCE
   ZERO FLAG IS SET IF ERROR (NOTHING ATTACHED OR
     RESISTANCE IS TOO HIGH)
; AX,CX,DX,SI CHANGED
  BX, BP, SP, DI PRESERVED
max count
              equ Offfh
joyin proc near
                              :disable interrunts
                              ; during count
       mov
               cx, max count
                              ;more than highest
                              ; possible count
       xor
       mov
               dx,201h
       out
              dx,a1
                              ;start the pulses
next:
       in
               al,dx
                              ;get bits
       test
               a1.b1
       je
              done
```

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```
inc
        100p
                next
done:
        cmp
                si,max_count
                              ;set zero flag
                               ; as error status
        sti
                                 :enable interrupts
        ret
joyin endp
  THIS SUBROUTINE PRINTS THE STRING
   POINTED TO BY SI
        SI - POINTER TO STRING
    DUTPUT
        STRING APPEARS ON SCREEN
    HOON PETHON
; THE VALUE ZERO IN A STRING IS NOT PRINTED
   IF FOLLOWED BY:
      0 - THE END OF THE STRING HAS BEEN REACHED
      1 - THE NEXT BYTE WILL BE NEW ATTRIBUTE BYTE
   2 - THE NEXT BYTE WILL BE NEW X INCREMENT
            FOR SPACING BETWEEN CHARACTERS
      3 - THE NEXT BYTE WILL BE NEW Y INCREMENT
      4 - THE NEXT BYTE WILL BE NEW X LOCATION
      5 - THE NEXT BYTE WILL BE NEW Y LOCATION
showtxt proc near
        lodsb
                                ;get a character from string
        mov
                [parm],al
                                ;save the character
                after0
                                ;special function
; SET CURSOR POSITION
        mov
                d1,[px]
                                ;set x location for character
        mov
                dh,[py]
                                ;set y location for character
        mov
                                 ;set to set cursor position
        xor
                bh.bh
                                ;page number 0
        int
                10h
                                ;set cursor position
; PRINT THE CHARACTER
        mov
                al,[parm]
                                ; character to print
        mov
                cx,1
                                ;number of characters
        mov
                                 ;set to write attribute/character
        mov
                bl,[pattr]
                                ;set attribute
                                 ;write the character to screen
; FIND CURSOR POSITION FOR NEXT CHARACTER
        mov
                al,[pxinc]
                                ;find new x position
        add
                [px],a1
                al,[pyinc]
                                ;find new y position
;jmp to write next character
        mov
        imp
                showtxt
; HANDLE SPECIAL FUNCTION
after0:
        lodsb
                                :next character tells what to do
                al,al
        or
        ie
                                :if second consecutive zero then done '
                endsta
        xor
                bh,bh
                b1, a1
                                ;index for parameter to change
        mov
        lodsb
                                ;parameter value
                [bx+parm],al
        mov
                                :set parameter
       jmp
               showtxt
                                ;write next character
; RETURN TO CALLING ROUTINE
endstg:
showtxt endp
code ends
; DATA SEGMENT
data segment para public 'data'
; PARAMETER STORAGE SPACE
```

```
parm
pattr
       db
                0
pxinc
       db.
                0
pyinc
       db
                0
        dh
                0
ру
        db
                0
: STRING FOR DISPLAYING SCREEN LABELS
labstg db 0,1,07 ;white characters
               0,2,1 ;move 1 character to right
0,3,0 ;stay on same line
0,4,9 ;start in column 9
0,5,6 ;start in row 6
        db
        dh
        dh
        dh
                'Joysticks Buttons'
        db
               0,4,9 ;back to column 9
       dh
        db
                0,5,8 ;two lines down from last
        dh
                'AY
                               41'
        db
                0,4,9, 0,5,10
                               A2'
        dh
                'Ay
                0,4,9, 0,5,12
        dh
        dh
                IRY
                               B1 '
        db
                0,4,9, 0,5,14
        dh
                'Ву
                               B21
                      ;end of string
        dh
                0.0
; STRING TO DISPLAY INPUT VALUES
valstg db
               0,4,13, 0,5,8
       dh
        db
                0,4,13, 0,5,10
jay
        db
        db
                0,4,13, 0,5,12
        dh
                0,4,13, 0,5,14
jby
        db
        db
                0,4,27, 0,5,8
                 0,4,27, 0,5,10
        db
ja2
        db
                0.4.27. 0.5.12
                0,4,27, 0,5,14
        db
jb2
        db
        db
                0,0
                                 ;end of value string
;
; LOOK UP TABLE FOR CHARACTER GIVEN A HEX DIGIT
chtbl db
                '0123456789ABCDEF'
data
        ends
        end
                showjoy
```

#### LISTING 3: CONTINUOUS DISPLAY OF THE STATE OF ALL INPUTS ON THE GAME ADAPTER CARD

```
stack segment para stack 'stack'
       db
              64 dup ('stack
stack ends
code
      segment para public 'code'
       assume cs:code,ds:data,es:nothing
; THIS PROGRAM CONTINUALLY DISPLAYS THE STATE OF
   ALL THE INPUTS ON THE GAME ADAPTER CARD
   (RETURNS TO DOS WHEN KEY IS PRESSED)
showjoy proc far
; SET FOR RETURN TO DOS
       push
               ds
       push ax
; SET DATA SEGMENT
               ax,data
               ds,ax
       mov
```

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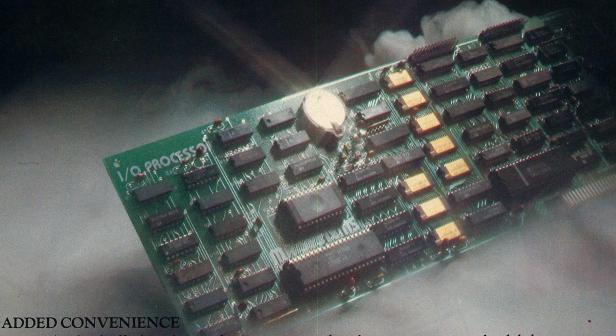
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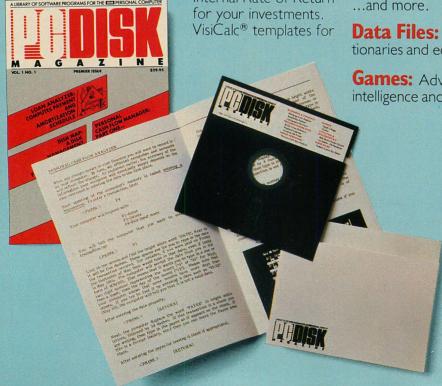
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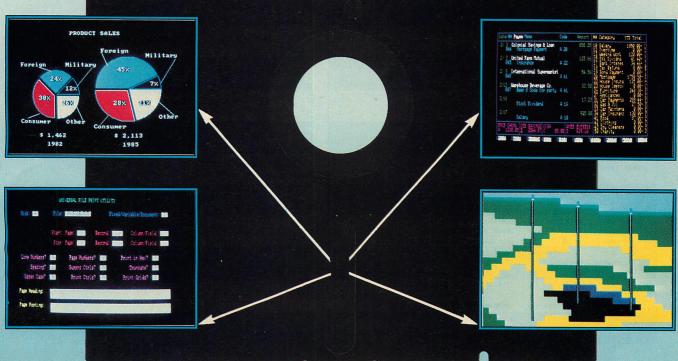
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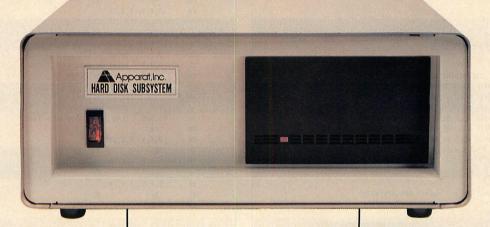
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### GAME ADAPTER

```
; CLEAR SCREEN DISPLAY
MOV
               cx,48 ;100p 48 times
clear loop:
        push
                        ;save counter
                ah . 14
                        ;BIOS print character function
        mov
                        ;char to print is line feed ;character color if we are in
                al 10
        mny
        mov
                61.3
                        ; graphics mode
                        ;display page 0 if we are in
                bh,0
        mov
                        ; text mode
         int
                        ;call BIOS print function to print
                        ; line feed. After 48 times,
                        ; the screen will be clear
                CX
                       ;get counter back
        pop
        1000
                clear loop
                               ;do next line feed
 ; SET UP LABELS
                si,offset labstq
        mov
        call showtxt
; READ INPUTS FROM GAME CONTROL ADAPTER
read again:
        call
                joyin
                                 ;get all four readings
        push
                bx
                                ;save JBX and JBY
                                 ; ditto
        push
                bx
                                ;save JAX and JAY
        push
                ax
                                 ;put JAX in low byte of si
        mov
                si,ax
                di,offset jax
                                prepare for printing
        mov
        call
                mkstg
                                 ; result
                                 ;get JAX/JAY values
        pop
                ax
                                ;put JAY in low byte of si
                al,ah
        mov
                si,ax
        mov
                di,offset jay
                                prepare for printing
        mov
        call
                mkstg
                                 ; result
                                 ;get JBX/JBY
        pop
                                 ;put JBX in low byte of si
        mov
                di,offset jbx
                                ;prepare for printing
        mov
        call
                                ; result
                mkstq
                bx
                                 ;qet JBX/JBY
        pop
                bl.bh
                                 ;put JBY in low byte of si
        mov
        mov
                si,bx
                di,offset jby ;prepare for printing
        mov
        call
                mkstq
                                 ; result
        call
                delay
                                 ;delay to prevent interference
                                ;get button bits
                al,dx
                di,offset jal
        mov
                                ;place for string
                al.10h
                                ;test button JA1
        call.
                                ;put in string
        mov
                di,offset ja2
                                ;place to put string
        test
                a1,20h
                                 ;test button JA2
        call
                updown
                                 ;put in string
                di,offset jbl ;place to put string
        mov
        test
                a1,40h
                                :test button JB1
        call
                updown
                                ;put in string
                di,offset jb2
                                ;place to put string
        mov
        test
                a1,80h
                                ;test button JB2
        call
                                ;put in string
; PRINT ALL THE VALUES ON THE SCREEN
                si, offset valstg
        call.
                showtxt
                                ;put values on screen
; TEST FOR KEY PRESS
        mov
                ah,1
                                ; if a key has not
                               ; been hit then
; do it again
        int
                16h
        jz
                read again
        mov
                ah,0
                                ; else get the key
        int
                16h
        ret
                                ; and return to DOS
showjoy endp
; CONVERT JOYSTICK VALUE IN SI TO STRING
   FOR PRINTING
mkstq proc
               near
        and
                si noffh
        cmp
                si, max count
                                ; joystick not attached
        je
                error
        mov
                cx,4
                                ;four characters to be made
```

```
;save all values
       mov
               bx.si
nxch:
               si.bx
                               remaining digits
       mov
               si,Ofh
       and
                               :isolate next digit
               al.[si+chtbl]
                               :find character for digit
       mov
                               ;put character in string
               [di+3],a1
       mov
                               ;next character goes to left
       dec
               di
                               ;position next digit
       shr
               bx.1
                               ; for conversion to a
       shr
               bx.1
                               ; character for printing
       shr
               bx.1
               bx.1
       1000
                               :go to do next character
               nxch
                               :finished with all four digits
       ret
error:
               word ptr [di+2], "A/" ;not available
               word ptr [di],"N "
       mov
                               ;finished
       ret
mksta endp
.
; CONVERT EQUAL FLAG STATUS TO 'ON' OR 'OFF' STRING
updown proc
               near
               down
       je
                                       ; if bit is zero
               word ptr [di], 'PU'
                                       ; if bit is one
       mov
               word ptr [di+2],' '
                                       ; then button
       mov
down:
               word ptr [di],'00'
       mov
                                       :button is down
               word ptr [di+2],'NW'
       mov
updown endp
; DELAY SO THAT READINGS DON'T INTERFERE WITH
; EACH OTHER
delay proc near
               cx.OfOOh
       mov
       1000
               here
       ret
delay endp
; THIS ROUTINE READS A RESISTIVE INPUT
   FROM THE GAME ADAPTER CARD
       INPUTS
               NONE
       OUTPUT
               VALUE PROPORTIONAL TO RESISTANCES
                 AL - JOYSTICK A X-COORDINATE
                  AH - JOYSTICK A Y-COORDINATE
                 BL - JOYSTICK B X-COORDINATE
                 BH - JOYSTICK B Y-COORDINATE
; UPON RETURN
    IF ANY OF AL, AH, BL OR BH CONTAIN 255 (FF HEX)
     THEN THE RESISTANCE IS TOO HIGH OR NOTHING
     IS ATTACHED TO THE CORRESPONDING INPUT
   AX.BX.CX.DX.BP.SI.DI CHANGED
   SP PRESERVED
equ Offh
max count
joyin proc
               near
       cli
                               :disable interrupts
                               ; during count
               cx,max count
                               ;more than highest
       mov
                               ; possible count
       mov
               dx,201h
                               ;si will keep jax & jay
                               ;di will keep jbx & jby
               di,di
       xor
               bp,0101h
                               ; one bit will stay on as
                               ; long as jax input bit
                               ; stays high, the other
                                 for as long as jay
```

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### GAME ADAPTER

```
; same as above for ibx &
                bx .bp
                                 ; jby
                                 start the pulses
                dx.al
next:
                        :get input bits
        in
                al.dx
                        ;copy into high byte
        mov
                ab.al
                        :shift jay bit into low
        shr
                ah.1
                        : bit of high byte position
                        set its count bit to zero if
        and
                bo.ax
                        ; jax or jay input bit is zero
                        add to counts if input bits
        add
                si bo
                        ; are still high
                         ;put jbx & jby input bits in
        chr
                av 1
                        ; proper position
        shr
                ax,1
                         ;set its count bit to zero if
        and
                bx,ax
                         ; jbx or jby input bit is zero
                        add to counts if input bits are
                di.bx
        add
                        ; still ones
                         ;do it 255 times
        100p
                ax.si
                        :transfer results to output
        mov
        mov
                        ; registers
        sti
                         ;re-enable interupts
                        return to calling routine
joyin
        endp
; THIS SUBROUTINE PRINTS THE STRING
    POINTED TO BY SI
        SI - POINTER TO STRING
    OUTPUT
        STRING APPEARS ON SCREEN
    UPON RETURN
; THE VALUE ZERO IN A STRING IS NOT PRINTED
    IF FOLLOWED BY:
      0 - THE END OF THE STRING HAS BEEN REACHED
      1 - THE NEXT BYTE WILL BE NEW ATTRIBUTE BYTE
.
      2 - THE NEXT BYTE WILL BE NEW X INCREMENT
           FOR SPACING BETWEEN CHARACTERS
      3 - THE NEXT BYTE WILL BE NEW Y INCREMENT
      4 - THE NEXT BYTE WILL BE NEW X LOCATION
      5 - THE NEXT BYTE WILL BE NEW Y LOCATION
showtxt proc near
        lodsb
                                ;get a character from string
        or
                al,al
                [parm],al
        mov
                                 :save the character
                after0
                                 ;special function
        je
  SET CURSOR POSITION
                                 ;set x location for character
                d1,[px]
        mov
                                 ;set y location for character
        mov
                dh.[py]
                ah,2h
                                 ;set to set cursor position
        mov
                                 ;page number 0
                                 ;set cursor position
        int
                10h
; PRINT THE CHARACTER
        mov
                al,[parm]
                                 ; character to print
                                 ;number of characters
        mov
                cx.1
                                ;set to write attribute/character
                ah,9h
        mov
                bl.[pattr]
                                 :set attribute
        mov
                                 ;write the character to screen
; FIND CURSOR POSITION FOR NEXT CHARACTER
                al.[pxinc]
                                ;find new x position
        mov
                [px].al
        add
                al,[pyinc]
        mov
                                 ;find new y position
                                 :imp to write next character
        imp
                showtxt
;HANDLE SPECIAL FUNCTION
after0:
        lodsb
                                 :next character tells what to do
                al,al
        or
                endsta
                                 :if second consecutive zero then done
        ie
        xor
                bh,bh
```

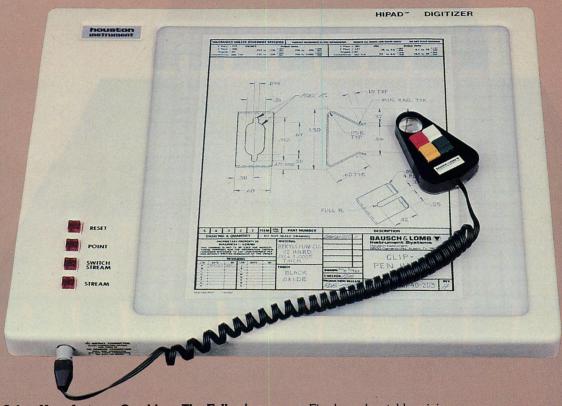
```
:index for parameter to change
        mov
                b1.a1
        lodsh
                                 :parameter value
                                 ;set parameter
;write next character
                [bx+parm].al
        mov
        imp
                showtxt
: RETURN TO CALLING ROUTINE
endsta:
showtxt endp
code ends
; DATA SEGMENT
        segment para public 'data
data
; PARAMETER STORAGE SPACE
TO SELECT
parm
pattr
pxinc
        db
pyinc
px
py
 STRING FOR DISPLAYING SCREEN LABELS
labstg db
                0.1.07 ;white characters
        db
                0,2,1 ;move 1 character to right
        dh
                0,3,0 ;stay on same line
                0,4,9 ;start in column 9
0,5,6 ;start in row 6
        db
        dh
                 'Joysticks
        db
                                Buttons
                 0,4,9 ;back to column 9
        dh
        dh
                0.5.8 ; two lines down from last
                'Ax
        dh
                              Al'
        db
                 0,4,9, 0,5,10
        db
                 'Ay
                0.4.9. 0.5.12
        db
; STRING FOR DISPLAYING SCREEN LABELS
labstg db
                0,1,07 ;white characters
        db
                 0,2,1 ;move 1 character to right
        db
                0,3,0
                        ;stay on same line
        db
                 0,4,9
                        ;start in column 9
        db
                 0,5,6 ;start in row 6
                 'Joysticks Buttons'
                0,4,9 ;back to column 9
        db
                 0,5,8
                       ;two lines down from last
        db
                 'Ax
                                A1'
        db
                 0,4,9, 0,5,10
                 0,4,9, 0,5,12
        db
                'Bx
        db
                0,4,9, 0,5,14
                                R21
        db
                 ' By
                         ;end of string
        dh
                0.0
; STRING TO DISPLAY INPUT VALUES
valstg db
                0,4,13, 0,5,8
jax
        db
        dh
                 0,4,13, 0,5,10
jay
        db
        dh
                 0,4,13, 0,5,12
jbx
        db
        db
                 0,4,13, 0,5,14
jby
        db
        db
                 0,4,27, 0,5,8
jal
        db
        dh
                 0.4.27. 0.5.10
ja2
        db
        db
                 0,4,27, 0,5,12
ib1
        db
                 0,4,27, 0,5,14
        db
ib2
        db
        db
                 0.0
                                 ;end of value string
; LOOK UP TABLE FOR CHARACTER GIVEN A HEX DIGIT
                 '0123456789ABCDEF'
        db
chtb1
data
        ends
        end
                 showjoy
```



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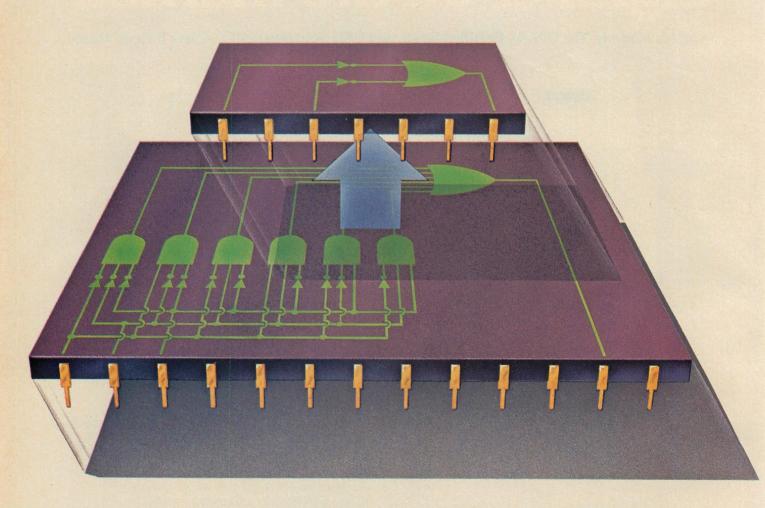
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Real-Time Analysis of Simple Digital Logic Circuits on the IBM PC using the Quine-McCluskey Technique

### MARK ALSOP

# BETTER CIRCUITS

#### WILLIAM H. MURRAY AND CHRIS H. PAPPAS

Because the simplest circuits are the best circuits, the ability to minimize Boolean functions is one of the most important tools designers can have at their disposal. Generally, designers use one of three basic techniques to achieve the simplest circuit design: Boolean algebra, Karnaugh Mapping, and Quine-McCluskey techniques. Each has advantages and disadvantages, but the Quine-McCluskey technique, because it is exactly specified, is applicable to computer implementation. Its power to simplify circuits will be demonstrated below.

### THREE REDUCTION TECHNIQUES

Boolean algebra can be used to alter Boolean expressions, but the complexity of the job increases sharply with the size of the expression. Because there can be many false starts when using Boolean algebra, it is not considered a systematic approach and is used only for the simplest expressions.

Karnaugh Mapping is a powerful tool for the reduction of complex logic expressions, and its ease of use makes it the favorite technique of logic designers. Using visual patterns of data display, designers can reduce complex equations by following a series of simple rules—the results of which are nothing less than outstanding. However, its dependence upon human pattern recognition is also its major drawback for computer implementation.

The Quine-McCluskey method of simplification is a tabular technique used to study all minterm (sum of products) combinations in order to form them into minimal combinations that will still satisfy the original function. With an IBM PC equipped with a parallel port and game adapter card, real-time analysis on a simple digital TTL circuit has been achieved. The host program was written in standard Pascal and will therefore require the use of the IBM Pascal Compiler. Two assembly language routines are called by the host program to interface it with the BIOS functions of the IBM PC. Therefore, the IBM Macro Assembler is also required to assemble these routines. Because of its size, 360K double sided diskdrives are needed to compile. (The authors will make a compiled program available to anyone without the software tools.)

### THE QUINE-McCluskey Method

W. V. Quine and E. J. McCluskey proposed an orderly and systematic approach for the reduction of Boolean expressions during the 1950s. Their techniques were not quickly adapted for general use because there were other methods that could produce identical results with less complexity. What Quine and McCluskey had hit upon, however, was a method that would be easily implemented with digital computers. By the end of the 1950s, several articles in trade journals showed this technique as an "Automatic

Design of Logical Networks." Fredrick Hill and Gerald Peterson illustrate the Quine-McCluskey method

hat Quine and McCluskey hit upon, however, was a method that would be easily implemented with digital computers.

in Introduction of Switching Theory and Logical Design published by John Wiley and Sons.

The Quine-McCluskey method will never appear as the best choice for hand-reduction of Boolean expressions for the reason that Karanaugh Mapping is simpler. However, for high speed, computer-assisted reductions, the Quine-McCluskey method is superior. Also, if the logic circuit or Boolean expression contains more than four inputs, Karnaugh Mapping loses its simplicity because of the required manipulation of map structures. The Quine-McCluskey method will suffer no additional complication.

### QUINE-MCCLUSKEY AT WORK

In the example that follows we'll consider a four-input logic circuit that produces the truth table of figure 1. The first step in implement-

William Murray and Chris Pappas are on the computer science faculty at Broome Community College in Binghamton, NY. Together they developed the hardware and small systems courses taught at the college.

m	Α	В	С	D	X
0	0	0	0	0	1
1	0	0	0	1	1
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	1
5	0	1	0	1	1
6	0	1	1 '	0	0
7	0	1	1	1	0
8	1	0	0	0	1
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	1
15	1	1	1	1	1

f(A,B,C,D) = m(0,1,2,4,5,8,10,13,14,15)Figure I

(SEE PAGE 121 FOR CAPTIONS TO FIGURES.)

# of 1s	Minterms	Binary Representation	Check
0	m (0)	0000	V
1	m (1)	0001	V
1	m (2)	0010	V
1	m (4)	0100	1
1	m (8)	1000	V
2	m (5)	0101	V
2	m (10)	1010	1
3	m (13)	1101	V
3	m (14)	1110	V
4	m (15)	1111	V

Figure 2

Grouping	1-Cube Binary Representation	Check
m (0, 1)	000X	V
m (0, 2)	0 0 X 0	V
m (0, 4)	0 X 0 0	V
m (0, 8)	X000	V
m (1, 5)	0 X 0 1	V
m (2, 10)	X 0 1 0	V
m (4, 5)	010X	V
m (8, 10)	10X0	V
m (5, 13)	X101	*
m (10, 14)	1X10	*
m (13, 15)	11X1	*
m (14, 15)	111X	*

Figure 3

ing the Quine-McCluskey technique is to order the minterms of figure 1 according to the number of ones they contain. Figure 2 shows five groups of minterms arranged in this fashion. Minterms from adjacent groups are then compared one at a time until a pair is found where only a one literal change exists between each of the literals of that pair. For example, m(0) and m(1) differ only in the last term (0 0 0 0 compared with 0 0 0 1) and therefore can be combined. The groupings are recorded in figure 3. When a minterm is used (at least once) a check is recorded in figure 2. Any term left unchecked after this sort will be plotted on a prime implicant chart. For our purposes, a prime implicant will be defined as an element required in the final expression to satisfy the original circuit logic. The minterm groups of figure 3 are then divided once again into groups according to the number of

ones contained in the binary representation. In our example, four new groups are formed. The sorting process is repeated, once again. The 2cube table shown in figure 4 is the result of combining terms of adjacent groups that differ by only one literal. In forming the 2-cube of figure 4, four terms were left unchecked in figure 3 and were then marked (\*) as possible prime implicants. By eliminating duplicate terms in the two-cube table, two more possible prime implicants are discovered and the search for prime implicants is ended.

The Prime Implicant Table, figure 5, is formed from all possible primes discovered during the reduction process. This table is always ordered in terms of cost. Cost refers to the number of un-X'ed terms in the binary form. Note that m(0, 1, 4, 5) and M(0, 2, 8, 10) have two un-X'ed terms while the remaining primes have three un-X'ed terms. Lower

cost terms are grouped first. Our first concern is to find essential primes. A prime is considered essential if it produces at least one unique X in any column of the prime implicant table. Thus, columns 1,2,4 & 8 (containing only one check) result from a prime implicant. Closer observation shows that these columns were produced by m(0, 1, 4, 5) and m(0, 2, 8, 10). Thus, they are marked to the right as essential prime implicants. The remaining four terms are referred to as secondary essential prime implicants and require further sorting.

Figure 6 shows a Secondary
Prime table. The element list contains only those elements, of the secondary primes, not covered by the essential prime implicants noted in the prime implicant table of figure 5. Because each of these secondary primes has the same cost value (i.e., the same number of un-X'ed terms in the binary representation),

Grouping	2-Cube Binary Representation	Check	
m (0, 1, 4, 5)	0 X 0 X	*	
m (0, 2, 8, 10)	X 0 X 0	*	
m (0, 4, 1, 5)	0 X 0 X	*	
m (0, 8, 2, 10)	X O X O	*	

Figure 4

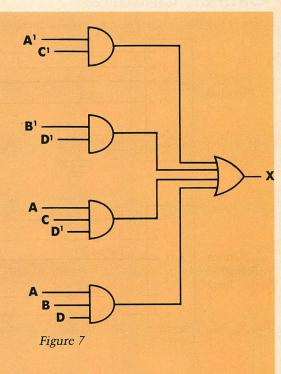
#### **Prime Implicant Table**

					e	len	ien	its			
Primes	<b>Binary Representation</b>	0	1	2	4	5	8	10	13	14	15
m (0, 1, 4, 5)	0 X 0 X	1	1			1					
m (0, 2, 8, 10)	X 0 X 0						1	1			
m (5, 13)	X101					1			1		
m (10, 14)	1X10							1		1	
m (13, 15)	11X1								1		1
m (14, 15)	111X									1	1

Figure 5

		е	lemen	ts
Secondary Primes	<b>Binary Representation</b>	13	14	15
m (5, 13)	X101	1		
m (10, 14)	1X10		1	
m (13, 15)	11X1			
m (14, 15)	111X		1	

Figure 6



it will not matter which is selected as long as each element is covered at least once. The final answer should always be based upon using the minimum number of secondary primes. Thus, the selection of m(10,14) and m(13,15) would be equally as correct as the selection of m(13,15) and m(14,15).

Combining the essential primes with the secondary essential primes, m(10,14) and m(13,15) from the previous two steps produces

#### f = A'C' + B'D' + ACD' + ABD

Figure 7 shows the logic implementation of this reduction. Once again, the magnitude of the reduction is readily apparent.

Two things should be immediately noted when using this technique. 1) while it lends itself to computer implementation, it is not a convenient technique for reduction by hand, 2) the examples chosen were simple. For more compli-

#### Figure 1: Four-Input Literal Truth Table

The table gives the output of a digital logic circuit. The example uses the minterms (terms that produce a one as output) to illustrate the Quine-McCluskey method of logic reduction.

### Figure 2: Minterms of Figure 1 Figure 1's minterns are arranged according to the number of ones in the original expression.

Figure 3: 1-Cube

The 1-cube is formed by grouping minterm elements from figure 2 that differ by one element between adjacent groups. The Xs represent positions where the elements differ for that group.

#### Figure 4: 2-Cube

This 2-cube is formed by grouping terms from the 1-cube table whose elements differ by one element. The second X marks this position. Note that the last two terms in the table are eliminated because they contain the same elements as the first two groups.

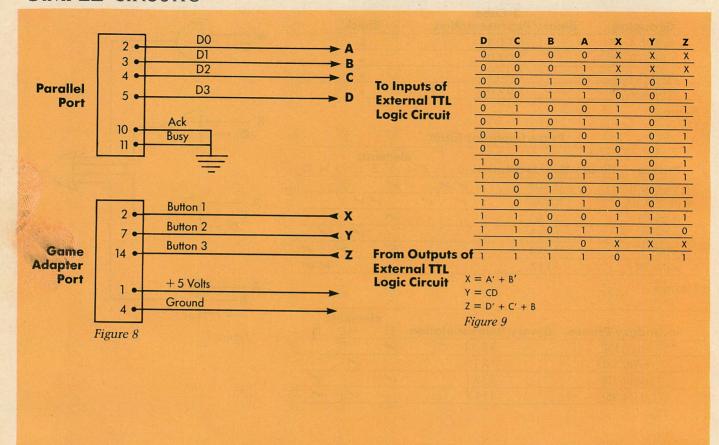
Figure 5: Prime Implicant Table
An essential prime is obtained for any column
that contains only one check. Hence, columns 1,
2, 3, 4, and 8 were produced by the essential
primes m (0, 2, 8, 10). Any prime not marked
after this initial inspection is called a secondary
essential prime because it contains elements also
specified by other secondary essential primes.

#### Figure 6: Secondary Prime Table

This table is derived from the prime implicant table. The elements of the secondary primes, which were covered by the essential primes, have been removed. Cost factors are now applied to make the final reductions.

### Figure 7: Implementation after Quine-McCluskey

An implementation of the final Boolean expression obtained in our example, after the Quine-McCluskey reduction method was employed.



cated functions, the process gets involved when proceeding by hand, to say nothing of special considerations such as DON'T CARE statements. If a more detailed treatment of this topic is desired, Hill and Peterson's book, which was mentioned earlier, is highly recommended.

#### SOFTWARE DESCRIPTION

Pascal was chosen as the programming language when we determined the approximate length of the program. We soon regretted that we had made such a choice, because we found that IBM Pascal does not directly access the game adapter or the printer port, which were to provide the real-time access to the IBM PC. Solving this problem involved the use of two assembly language routines, which interface with the Pascal host program. The assembly language program SEND.ASM outputs a sequence to the parallel port (printer port), which is used as the

input to the TTL logic circuit under test. Listing 1 of this program shows that SEND. ASM accepts one variable from the host program and outputs it through the BIOS interrupt (17H). (All listings follow this article.) Up to four literals (A,B,C,D) can be specified for the inputs to the TTL circuit under test.

The assembly language program RECEIVE. ASM (listing 2) reads the game adapter card. It sends the status of the "buttons," which are either logic 1 or logic 0, to the Pascal host program as the outputs from the TTL logic circuit under test. The Pascal host program will accept three outputs (X,Y,Z) from a TTL circuit. The user can also specify the location of DON'T CARE statements at the time the program is started. The computer then follows this procedure: it steps through each Boolean combination, outputs the sequence to the logic circuit, reads the output of the logic circuit, and

#### Figure 8: Wiring Interface

Schematic diagram of the wiring interface connecting the parallel port and the game adapter port of the IBM PC to the TTL logic circuit.

#### Figure 9: Screen Dump of Experimental Circuit

This shows the use of DON'T CARE statements (Xs in the truth table). Note that three outputs are evaluated and reduced.

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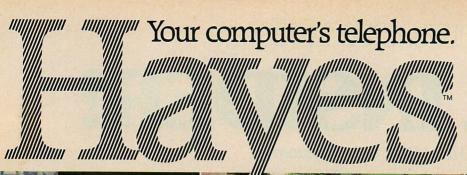
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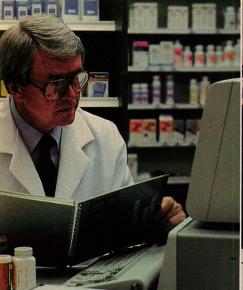
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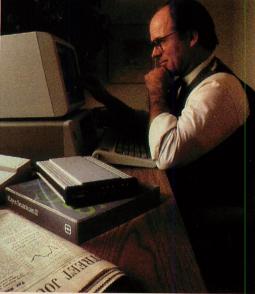




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### SIMPLE CIRCUITS

stores the results in a matrix. When all the possible combinations have been read, the program reduces the data using the Quine-McCluskey technique described earlier. The program (listing 3) then draws the truth table for the circuit and lists the reduced output.

sequences. (A typical propagation delay for simple TTL gates is 10 nanoseconds.) For now-critical applications, figure 8 shows all hardware interface needed between the IBM PC and your circuit. If the circuit is complex, with a rather high propagation delay, a timing loop between SEND (TEMP) and RECEIVE

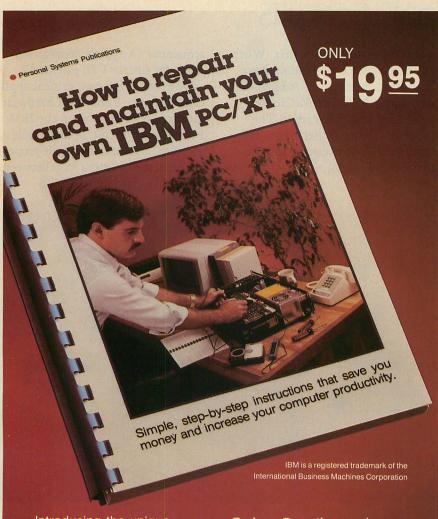


### REAL-TIME CIRCUIT ANALYSIS

Real-time analysis of a circuit is achieved by sending the correct logic to the inputs of the external circuit via the parallel port of the computer. Where fan-out and other isolation conditions are not critical. the parallel port can drive the external circuit directly. If isolation is required, then the addition of a latch/ driver to each of the four outputs may be required. The output of the external circuit is then measured via the game adapter port to determine whether it is logic 1 or logic 0 before the next sequence is received from the parallel port. As long as the propagation delay of the external circuit is less than the delay between the output to the parallel port and the input to the game adapter, timing will be no problem.

The program, in its current form, produces a .5 millisecond delay between the READ and WRITE

(BUT1, BUT2, BUT3, BUT4) may be required in the host Pascal program to prevent read errors. The 5volt power supply of the IBM PC was used to drive the example circuits. The typical current requirement for simple TTL logic gates is 2 milliamperes. One hundred such gates would require 2/10 of an ampere, well within the specifications of the IBM PC power supply (unless your machine is loaded with highpower boards). If the external TTL circuit requires significant power or if it contains its own power supply, connect the ground of the IBM PC to the ground of the external TTL device. Caution: Be careful when connecting any external wiring to the IBM PC in order to avoid possibly causing damage to both devices. Figure 9 is a screen dump of a circuit that was analyzed with the software program. This circuit was connected with the wiring interface found in figure 8.



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### SIMPLE CIRCUITS

irect application
of the QuineMcCluskey method of circuit reduction is
important to logic designers as well as to those working with actual hardware
circuits.

#### **APPLICATIONS**

The program shown here illustrates the important concepts of the Quine-McCluskey method of circuit reduction. Direct application of these concepts is important to logic designers as well as to those working with actual hardware circuits. We have used this program at the college level to reinforce and teach the concepts of circuit reduction. The program is valuable for the concepts of circuit reduction, but also for a direct application of computer aided real-time analysis.

The authors will make available a (SSDD) diskette, using DOS 2.0, containing the listings in this article along with a compiled version. This will eliminate the need for the Pascal Compiler, Macro Assembler, and 360K disk drives required to compile the program. The diskette will also contain another program called KEYTTL, which permits data to be entered with the keyboard rather than an external circuit. This program will be useful for checking hand-reductions of Boolean equations. A four foot wiring harness which connects to the IBM PC's parallel port and game adapter and terminates into a 16-pin dip header is also available. The diskette is \$25 and the wiring harness is \$35, including shipping. Pennsylvania residents should include 6 percent sales tax. Please allow 3 to 5 weeks for processing. All orders and inquiries should be sent to NINEVEH NA-TIONAL RESEARCH, P.O. Box

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#### LISTING 1 SEND CHARACTER TO PARALLEL PORT

**SEND.ASM** is the interface to the Pascal Host program responsible for the logic output through the parallel port. 

; PROGRAM DESIGNED TO OUTPUT A CHARACTER TO PARALLEL PORT FOR USE WITH ;TTL PROGRAM. THIS PROGRAM SERVES AS THE 'INCREMENTER' FOR THE ; INPUT COMBINATIONS TO THE TTL LOGIC :\*\*\*\*COPYRIGHT 1983 BY WILLIAM H. MURRAY & CHRIS H. PAPPAS\*\*\*\*

MYCODESEGMENT BYTE PUBLIC ASSUME CS:MYCODE PUBLIC SEND SENDPROCEAR PUSHBP; SAVE BP REGISTER MOVBP. SP: ESTABLISH NEW BP VALUE MOVDX, OOH; BASE ADDRESS OF PRINTER MOVSI,[BP]+6:GET LOCATION OF VALUE MOVAX,[SI]; MOVE DATA INTO AX REG. MOVAH, OOH; CLEAR AH VALUE TO PRINT INT17H:PRINT CHAR, IN AL REG POPBP;GET OLD BP VALUE RET2; RESET STACK VALUES SENDENDP: END PROCEDURE MYCODEENDS: END SEGMENT END: END PROGRAM

#### LISTING 2 RECEIVE DATA FROM PUSHBUTTONS

RECEIVE.ASM is the interface to the Pascal Host program responsible for input through the game adapter port. 

:PROGRAM READS THE PUSHBUTTONS ON THE GAMEADAPTER BOARD THESE INPUTS ARE CONNECTED TO THE OUTPUTS OF THE TTL LOGIC :CIRCUIT USED BY THE TTL PROGRAM ;\*\*\*\*COPYRIGHT 1983 BY WILLIAM H. MURRAY & CHRIS H. PAPPAS\*\*\*\*

STACKSEGMENTPARA STACK

STACKENDS

DATASEGMENT

READDBO; READ IS TEMP STORAGE BUTIDBO

BUT 20BO

BUT3DB0

BUT 4DBO

DATA ENDS

ICODESEGMENTBYTE PUBLIC

ASSUME CS: ICODE, DS: DATA, SS: STACK

PUBLIC RECEIVE

RECEIVE PROCEAR

PUSHBP; SAVE ORIGINAL BP DATA

MOVBP, SP; SET BP TO SP VALUE PUSHDS; SAVE DATA SEG. VALUE

MOVAX, DATA; SET NEW DATA SEG. VALUE

MOVDS, AX

MOVAL, OFFH; TRIGGER GAME ADAPTER

MOVDX,0201H;201 IS PORT VALUE OUTDX AL

INAL, DX

MOVREAD, AL; PREPARE TO DECODE BUTTONS

ANDAL, OF OH: KEEP UPPER 4 BITS MOVCL . 04H

RORAL, CL: MOVE TO LOWER 4 BITS MOV READ AL

ANDAL, O1H

JZL0C5

MOVBUT1,01H; IF +5 VOLT SAVE A 1

LOC5:MOVAL, READ ANDAL, 02H

JZL0C6

MOVBUT2,01H

LOC6: MOVAL, READ

```
ANDAL . 04H
JZTERMIN
MOVBUT3.01H
TERMIN: POPBX; PUT ORIG DS IN BX
MOVAH, BUT 4
MOVAL BUT3
PUSH AX
MOVAH BUT 2
MOVAL, BUT1
PUSHAX
MOVAL, OOH; PREPARE RESET
MOVREAD, AL
MOVBUT1, AL
MOVBUT2, AL
MOVBUT3, AL
MOVBUT4, AL
MOVDS, BX; PUT ORIG DS BACK
MOVDI,[BP]+12; TRANSFER STACK TO PASCAL
POPAX
MOV[DI], AL
MOVDI,[BP]+10
MOV[DI],AH
MOVDI,[BP]+8
POPAX
MOV[DI],AL
MOVDI,[BP]+6
MOV[DI], AH
POPBP; RETURN ORIG BP
RET8; RESET STACK
RECEIVEENDP; END PROCEDURE
ICODEENDS: END ICODE SEGMENT
END: END PROGRAM
```

#### LISTING 3 PROGRAM TTL

```
* (c) 1983 by DR. WILLIAM H. MURRAY and CHRIS H. PAPPAS
PROGRAM TTL (INPUT. OUTPUT):
TYPE HOLDER1= ARRAY[0..15] OF ARRAY[0..2] OF INTEGER;
    HOLDER2 = ARRAY[0..40] OF ARRAY[0..4] OF INTEGER;
    HOLDER3= ARRAY[0.,50] OF ARRAY[0..7] OF INTEGER;
    HOLDER4= ARRAY[0..20] OF ARRAY[0..7] OF INTEGER;
     HOLDER5= ARRAY[0..15] OF ARRAY[0..11] OF INTEGER;
     HOLDER6= ARRAY[0..15] OF ARRAY[0..11] OF INTEGER;
     HOLDER7 = ARRAY[0..15] OF ARRAY[0..1] OF INTEGER;
```

```
VAR
 A,B,C,D
                                    :BOOLEAN;
 LITERALS, OUTMORE, OUTINDEX, SUM : INTEGER;
 LIMIT, L, K, I, P, J, T, COUNT
  BUT1, BUT2, BUT3, BUT4, TEMP
                                     : INTEGER;
  TABLE: ARRAY[0..15] OF ARRAY[0..6] OF INTEGER;
  TABLE2: ARRAY[0..15] OF ARRAY[0..6] OF INTEGER;
  STORAGE: ARRAY[0..15] OF INTEGER (*LOCATION OF DON'T CARES*);
```

PROCEDURE SEND (VAR COUNTIN: INTEGER); EXTERNAL;

PROCEDURE INFORM;

IF LITERALS=4 THEN LIMIT:=15;

CH: CHAR:

VAR

PROCEDURE RECEIVE (VAR BUT1, BUT2, BUT3, BUT4: INTEGER); EXTERNAL:

```
* Procedure INFORM asks the user to define the number of input
* signals into the TTL circuit. This information is stored in the
* array LIMIT. The user must also define the number of output
* signals from the circuit, stored in OUTMORE. Lastly, the location
* of DON'T CARE statements must be entered using the decimal equiv-
* alent of the minterm, stored in STORAGE.
```

```
BEGIN (*PROCEDURE INFORM*)
COUNT:=0;
FOR L:=1 TO 30 DO
 WRITELN(' ');
WRITELN('Enter the number of inputs to the circuit (MAX of 4) ');
READLN (LITERALS);
IF LITERALS=1 THEN LIMIT:=1;
IF LITERALS=2 THEN LIMIT:=3;
IF LITERALS=3 THEN LIMIT:=7;
```

WRITELN('Enter the number of outputs from the circuit (MAX of 3) ');

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```
READLN (OUTMORE);
 WRITELN('Are there any DON''T CARE statements?'); WRITELN('Type ''Y'' for YES and ''N'' for NO');
 READ (CH);
 IF (CH='Y') THEN
 REGIN
   WRITELN;
   WRITELN('Enter location of DON''T CARE STATEMENTS');
   WRITELN('Type the DECIMAL LINE LOCATION of each');
   WRITELN('followed by a space.');
    WRITELN('After the LAST ENTRY type a PERIOD.');
    REPEAT
     READ(STORAGE[COUNT], CH);
     COUNT: =COUNT+1;
   UNTIL CHe'.';
   END;
END; (*PROCEDURE INFORM*)
* Because this program was written using TOP-DOWN DESIGN, where each *
* procedure was written in the order in which it would be executed,
* it was necessary to use the FORWARD statement. This indicates the *
* usage of a sub-program which will be defined later in the program. *
PROCEDURE SORT1:
FORWARD:
PROCEDURE PRINTIT:
FORWARD:
* PROCEDURE STEP using LIMIT generates the appropriate number of
* output signals to the TTL circuit. The output from the circuit
\star is stored in TABLE. The output column of TABLE is changed to a 1
* logic wherever there is a DON'T CARE statement in STORAGE. TABLE is *
* copied into TABLE2 to allow manipulation of the data. The last
* part of this procedure is used to determine, for each of the output *
* columns in OUTMORE, three conditions: 1) the case where the output
* is all zeros, 2) the case where the output is all ones, and 3) the *
* case where the reduction process is necessary. *
PROCEDURE STEP;
  M N. INTEGER .
BEGIN(*PROCEDURE STEP*)
  FOR I:= 0 TO LIMIT DO
    BEGIN
    CASE I OF
    O: BEGIN
      TABLE[0,3]:=0;
      TABLE[0.2]:=0:
      TABLE[0.1]:=0:
      TABLE[0.0]:=0:
      END:
    1:BEGIN
      TABLE[1,3]:=1;
      TABLE[1,2]:=0;
      TABLE[1,1]:=0;
      TABLE[1,0]:=0;
      END:
    2:BEGIN
      TABLE[2.3]:=0:
      TABLE[2,2]:=1;
      TABLE[2,1]:=0;
      TABLE[2.0]:=0:
      END:
    3:BEGIN
      TABLE[3,3]:=1;
      TABLE[3,2]:=1:
      TABLE[3,1]:=0;
      TABLE[3,0]:=0;
      END;
    4:BEGIN
      TABLE[4,3]:=0;
      TABLE[4,2]:=0;
       TABLE[4,1]:=1;
      TABLE[4,0]:=0;
      END;
      TABLE[5,3]:=1;
      TABLE[5,2]:=0;
      TABLE[5,1]:=1;
```

```
TABLE[5,0]:=0;
        FND:
      6-REGIN
        TABLE[6,3]:=0;
        TABLE[6.2]:=1:
        TABLE[6,1]:=1;
        TABLE[6,0]:=0;
        END:
      7:BEGIN
        TABLE[7,3]:=1;
        TABLE[7,2]:=1;
        TABLE[7,1]:=1;
        TABLE[7,0]:=0;
       END:
      8:BEGIN
        TABLE[8,3]:=0;
        TABLE[8.2]:=0:
        TABLE[8,1]:=0;
        TABLE[8,0]:=1;
       END:
     9:BEGIN
       TABLE[9,3]:=1;
        TABLE[9,2]:=0;
        TABLE[9,1]:=0;
        TABLE[9,0]:=1;
       END:
    10:BEGIN
       TABLE[10,3]:=0;
        TABLE[10,2]:=1;
        TABLE[10.1]:=0:
        TABLE[10,0]:=1;
       END:
    11:BEGIN
       TABLE[11,3]:=1;
       TABLE[11,2]:=1;
       TABLE[11,1]:=0;
       TABLE[11,0]:=1;
       END;
    12:BEGIN
       TABLE[12,3]:=0;
       TABLE[12,2]:=0;
       TABLE[12,1]:=1;
       TABLE[12,0]:=1;
       END;
    13:BEGIN
       TABLE[13,3]:=1;
       TABLE[13,2]:=0;
       TABLE[13,1]:=1;
       TABLE[13,0]:=1;
       END;
    14:BEGIN
       TABLE[14,3]:=0;
       TABLE[14,2]:=1;
       TABLE[14,1]:=1;
       TABLE[14,0]:=1;
       END;
    15:BEGIN
       TABLE[15,3]:=1;
       TABLE[15,2]:=1;
       TABLE[15,1]:=1;
       TABLE[15,0]:=1;
       END;
END; (*CASE I OF*)
SEND (TEMP);
RECEIVE (BUT1, BUT2, BUT3, BUT4);
TABLE[1,4]:=BUT1;
TABLE[1,5]:=BUT2;
TABLE[I,6]:=BUT3;
FOR P:=0 TO COUNT-1 DO
  BEGIN
    TABLE[STORAGE[P], 4]:=1;
    TABLE[STORAGE[P],5]:=1;
    TABLE[STORAGE[P],6]:=1;
  END;
FOR L:=0 TO 15 DO
  BEGIN
   FOR K:=0 TO 6 DO
      BEGIN
        TABLE2[L,K]:=TABLE[L,K]
      FND
  END:
```

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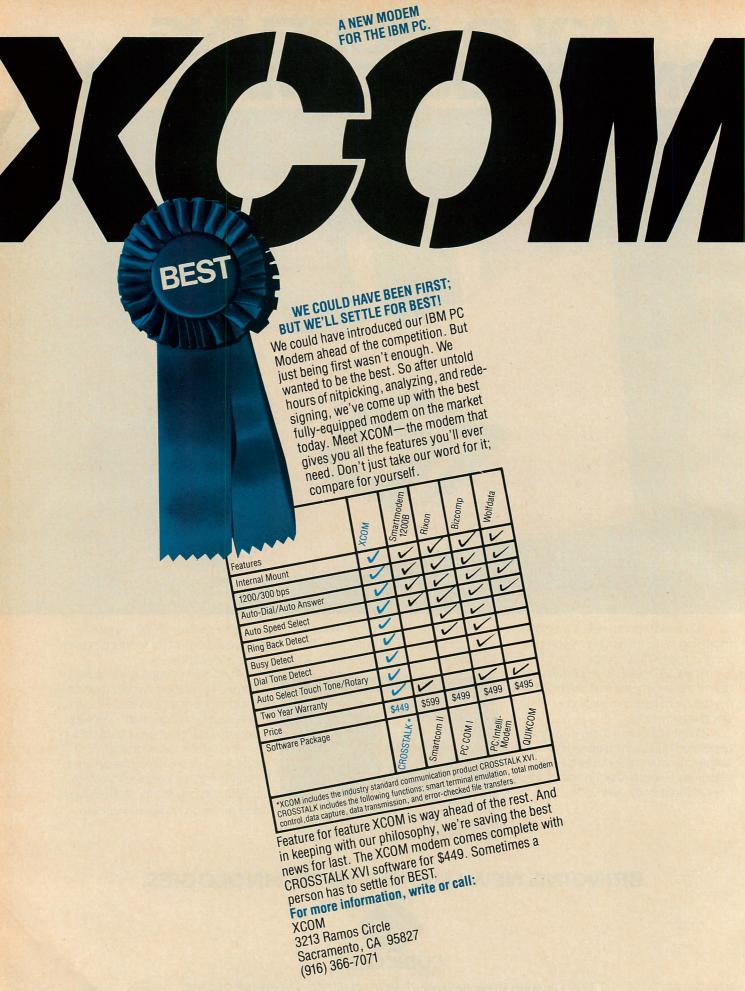
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```
PRINTIT;
FOR M:=4 TO OUTMORE+3 DO
  BEGIN
    SUM: =0:
    FOR N:=0 TO LIMIT DO
      BEGIN
        IF TABLE2[N,M]=1 THEN
         SUM:=SUM+1;
      END;
    IF M=4 THEN
      BEGIN
        IF (SUM=0) OR (SUM-COUNT=0) THEN
          WRITELN('X = 0')
          ELSE IF SUM=LIMIT+1 THEN
            WRITELN('X = 1')
            ELSE
              BEGIN
                OUTINDEX: =4:
                 SORT1;
              END:
       END;
     IF M=5 THEN
       BEGIN
         IF(SUM=0)OR(SUM-COUNT=0) THEN
           WRITFIN('Y = 0')
           ELSE IF SUM=LIMIT+1 THEN
             WRITELN('Y = 1')
             ELSE
                BEGIN
                  OUTINDEX: =5;
                  SURT1;
                END;
END;
PROCEDURE SORTA.
VAR
  FOURS: HOLDER5;
  INDEX4, PRIME4, K: INTEGER;
BEGIN(*PROCEDURE SORT4*)
  INDEX4:=0:
  IF PRIME3=1 THEN
  BEGIN
```

```
FOR K:=0 TO 11 DO
      IF M=6 THEN
        BEGIN
          IF(SUM=0)OR(SUM-COUNT=0) THEN
           WRITELN('Z = 0')
           ELSE IF SUM=LIMIT+1 THEN
             WRITELN('Z = 1')
             ELSE
               BEGIN
                 OUTINDEX:=6;
                 SORT1;
               END;
        END;
END; (*PROCEDURE STEP*)
PROCEDURE SORT2(ONES: HOLDER1; INDEX1: INTEGER);
* PROCEDURE SORT1 using TABLE2 takes the decimal equivalent of the
* minterms and orders them according to the number of one's in the
* term. (The beginning step for Quine-McClusky reduction.) This
* generates the ONES array.
PROCEDURE SORT1;
 ONES: HOLDER1:
 INDEX1, COLUMN, ROW: INTEGER;
BEGIN(*PROCEDURE SORT1*)
  COLUMN: =OUTINDEX:
   INDF X1:=0:
    IF TABLE2[0,COLUMN]=1 THEN
     BEGIN
       ONES[INDEX1,0]:=0;
       ONES[INDEX1,1]:=0;
       ONES[INDEX1,2]:=0;
       INDEX1: = INDEX1+1;
     END;
   FOR ROW: = 0 TO LIMIT DO
     BEGIN
       IF TABLE2[ROW.COLUMN]=1 THEN
```



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```
IF (ROW=1)OR(ROW=2)OR(ROW=4)OR(ROW=8) THEN
                     ONES{INDEX1,0]:=ROW;
                     ONES[INDEX1,1]:=1;
                     ONES[INDEX1,2]:=0;
                     INDEX1:=INDEX1+1:
                   END:
           FOR ROW:=0 TO LIMIT DO
      REGIN
        IF TABLE2[ROW, COLUMN]=1 THEN
          IF (ROW=3)OR(ROW=5)OR(ROW=6)OR(ROW=9)OR(ROW=10)OR(ROW=12) THEN
            BEGIN
              ONES[INDEX1,0]:=ROW;
               ONES[INDEX1,1]:=2;
               ONES[INDEX1,2]:=0;
               INDEX1:=INDEX1+1;
       END;
     FOR ROW:=0 TO LIMIT DO
       BEGIN
          IF TABLE2[ROW, COLUMN]=1 THEN
           IF (ROW=7)OR(ROW=11)OR(ROW=13)OR(ROW=14) THEN
                ONES[INDEX1,0]:=ROW;
                ONES[INDEX1,1]:=3;
                ONES[INDEX1,2]:=0;
                INDEX1:=INDEX1+1;
       END;
      IF (LIMIT=15)AND(TABLE2[15,COLUMN]=1) THEN
        BEGIN
          ONES[INDEX1,0]:=15;
          ONES[INDEX1,1]:=4;
          ONES[INDEX1,2]:=0;
          INDEX1:=INDEX1+1;
       END;
      SORT2(ONES, INDEX1)
END; (*PROCEDURE SORT1*)
PROCEDURE SORT3(TWOS: HOLDER2; INDEX2, PRIME: INTEGER);
```

```
FORWARD:
* PROCEDURE SORT2 uses the ONES array to generate the first grouping *
\star by comparing the groups that differ by only one number of ones.
* This process creates the TWOS array. The last part of SORT2 copies *
* all of those minterms which were not used for any reductions. *
PROCEDURE SORT2:
VAR
  TWOS: HOLDER 2:
  INDEX2, PRIME: INTEGER:
BEGIN(*PROCEDURE SORT2*)
  INDEX2:=0:
  IF INDEX1=1 THEN
    BEGIN
      TWOS[0,0]:=0;
      TWOS[0,1]:=ONES[0,0];
      TWOS[0,2]:=0;
      TWOS[0,3]:=0;
      TWOS[0,4]:=0;
      INDEX2:=INDEX2+1;
    ELSE FOR I:=0 TO INDEX1-2 DO
      BEGIN
        J:=I:
        WHILE (J<INDEX1-1) DO
          BEGIN
            IF (ONES[J+1,1]-ONES[I,1]=1) THEN
            BEGIN
              IF (ONES[J+1,0]-ONES[I,0]=1)OR
                 (ONES[J+1,0]-ONES[I,0]=2)OR
                 (ONES[J+1,0]-ONES[I,0]=4)OR
                  (ONES[J+1,0]-ONES[I,0]=8) THEN
                  TWOS[INDEX2,0]:=ONES[1,0];
                   TWOS[INDEX2,1]:=ONES[J+1,0];
                   TWOS[INDEX2,2]:=(ONES[J+1,0]-ONES[I,0]);
                   TWOS[INDEX2,3]:=0;
                   TWOS[INDEX2,4]:=ONES[I,1];
                   INDEX2: = INDEX2+1;
```



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```
ONES[1,2]:=1;
                 ONES[J+1,2]:=1;
               END:
            END;
          J:=J+1:
           END;
        END;
       PRIME: = INDEX2;
      FOR I:=0 TO INDEX1-1 DO
          IF ONES[1,2]=0 THEN
            TWOS[PRIME, 0]:=0;
             TWOS[PRIME,1]:=ONES[1,0];
            TWOS[PRIME, 2]:=0;
            TWOS[PRIME, 3]:=0;
            TWOS[PRIME, 4]:=0;
            PRIME: = PRIME+1;
          END;
        END;
      SORT3(TWOS, INDEX2, PRIME)
END; (*PROCEDURE SORT2*)
PROCEDURE ELIMINATE3(THREES: HOLDER3; INDEX3, PRIME2: INTEGER);
* PROCEDURE SORT3 using the TWOS array creates groupings of four min- *
* terms which agree on all but one digit, as does PROCEDURE SORT4 -
* (groupings of 8). The process for all three grouping procedures is
* the same. First, find those minterms that differ by only one
* number of ones and then do a subtraction of their decimal
* values. If the difference is a power of 2 then a new grouping can
PROCEDURE SORT3;
VAR
  THREES: HOLDER3:
  INDEX3, PRIME2: INTEGER;
BEGIN(*PROCEDURE SORT3*)
  INDEX3:=0;
  IF PRIME=1 THEN
```

```
THREES[0,0]:=0;
    THREES[0,1]:=0;
    THREES[0,2]:=TWOS[0,0];
    THREES[0,3]:=TWOS[0,1];
    THREES[0,4]:=TWOS[0,2];
    THREES[0,5]:=0;
    THREES[0,6]:=0;
    THREES[0,7]:=0;
    INDEX3:=INDEX3+1;
 FND
ELSE FOR I:=0 TO INDEX2-2 DO
 BEGIN
   J:=I;
   WHILE (J<INDEX2-1) DO
      BEGIN
        IF (TWOS[J+1,2]=TWOS[I,2])AND(TWOS[J+1,4]-TWOS[I,4]=1) THEN
            IF ((TWOS[J+1,0]-TWOS[I,0])=(TWOS[J+1,1]-TWOS[I,1])) THEN
             BEGIN
                IF (TWOS[J+1,0]-TWOS[I,0]=1)OR
                   (TWOS[J+1,0]-TWOS[I,0]=2)OR
                   (TWOS[J+1,0]-TWOS[I,0]=4)OR
                   (TWOS[J+1,0]-TWOS[I,0]=8) THEN
                  THREES[INDEX3,0]:=TWOS[I,0];
                  THREES[INDEX3,1]:=TWOS[I,1];
                  THREES[INDEX3,2]:=TWOS[J+1,0];
                  THREES[INDEX3,3]:=TWOS[J+1,1];
                  THREES[INDEX3,4]:=TWOS[1,2];
                  THREES[INDEX3,5]:=TWOS[J+1,0]-TWOS[1,0];
                  THREES[INDEX3,6]:=0;
                  THREES[INDEX3,7]:=TWOS[1,4];
                  TWOS[I,3]:=1;
                  TWOS[J+1,3]:=1;
                  INDEX3:=INDEX3+1;
                END:
              END;
          END:
    J:=J+1;
    END;
```

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```
END:
   PRIME2:=INDEX3;
   FOR I:=0 TO PRIME-1 DO
     BEGIN
       IF TWOS[1,3]=0 THEN
         BEGIN
           THREES[PRIME2,0]:=0;
           THREES[PRIME2,1]:=0;
           THREES[PRIME2,2]:=TWOS[I,0];
           THREES[PRIME2,3]:=TWOS[I,1];
           THREES[PRIME2,4]:=TWOS[1,2];
           THREES[PRIME2,5]:=0;
           THREES[PRIME2,6]:=0;
           THREES[PRIME2,7]:=0;
           PRIME2:=PRIME2+1;
     END:
   ELIMINATE3 (THREES, INDEX3, PRIME2)
END; (*PROCEDURE SORT3*)
PROCEDURE SORT4(REDUCED3:HOLDER4;POINTR,PRIME3:INTEGER);
* PROCEDURE ELIMINATE3 and PROCEDURE DELIMINATE4 serve the same
* function. Because the process of grouping can form new terms which *
* actually use the same minterms as a base, they must be eliminated. *
* For example, 0,2,8,10 (XOXO) is the same reduction as 0,8,2,10
* (XOXO). ELIMINATE3 eliminates duplicate terms with four minterms
* and ELIMINATE4 eliminates those terms in the FOURS array which are
* composed of 8 minterms.
*********************
PROCEDURE ELIMINATE3;
 REDUCED3: HOLDER4;
 TOTALS: ARRAY[0..20] OF INTEGER;
 SUM, POINTR, POINTT, K, FLAG, PRIME3: INTEGER;
BEGIN(*PROCEDURE ELIMINATE3*)
 POINTR: =0;
 POINTT:=0;
 FLAG: =0;
 TOTALS[0]:=0;
```

```
IF (PRIME2=1) THEN
   BEGIN
    FOR I:=0 TO 7 DO
      BEGIN
        REDUCED3[0, I]:=THREES[0, I];
      FND.
      POINTR:=POINTR+1;
  ELSE FOR I:=0 TO INDEX3-1 DO
    BEGIN
      SUM:=THREES[I,0]+THREES[I,1]+THREES[I,2]+
      THREES[I,3]+THREES[I,4]+THREES[I,5];
FOR J:=0 TO POINTT DO
        BEGIN
          IF SUM=TOTALS[J] THEN
           FLAG:=1:
        END;
      IF FLAG=0 THEN
        BEGIN
          FOR K:=0 TO 7 DO
           BEGIN
               REDUCED3[POINTR,K]:=THREES[I,K];
             TOTALS[POINTT+1]:=SUM;
           POINTR: = POINTR+1;
          POINTT: =POINTT+1;
        END;
      FLAG: =0;
    END;
  PRIME3:=POINTR;
  FOR I:=INDEX3 TO PRIME2-1 DO
    BEGIN
      FOR K:=0 TO 7 DO
          REDUCED3[PRIME3,K]:=THREES[I,K];
        END;
      PRIME3: =PRIME3+1;
    END;
  SORT4(REDUCED3, POINTR, PRIME3)
END; (*PROCEDURE ELIMINATE3*)
```

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```
PROCEDURE DELIMINATE4(FOURS: HOLDER5; INDEX4, PRIME4: INTEGER);
* PROCEDURE SORT4 - see PROCEDURE SORT3.
     FOURS[0.K]:=0:
   END:
 FOURS[0,4]:=REDUCED3[0,0];
 FOURS[0.5]:=REDUCED3[0.1]:
 FOURS[0,6]:=REDUCED3[0,2]:
 FOURS[0,7]:=REDUCED3[0,3];
ELSE FOR 1:=0 TO POINTR-2 DO
 REGIN
   WHILE (JEPOINTE-1) DO
       IF (REDUCED3[J+1,7]-REDUCED3[I,7]=1)AND
           (REDUCED3[J+1,4]=REDUCED3[I,4])AND
           (REDUCED3[J+1,5]=REDUCED3[1,5]) THEN
           IF (REDUCED3[J+1,0]-REDUCED3[I,0]=1)OR
              (REDUCED3[J+1,0]-REDUCED3[I,0]=2)OR
              (REDUCED3[J+1,0]-REDUCED3[I,0]=4)OR
             (REDUCED3[J+1,0]-REDUCED3[I,0]=8) THEN
              FOR K:=0 TO 3 DO
                BEGIN
                  FOURS[INDEX4,K]:=REDUCED3[I,K];
                END:
              FOURS[INDEX4,4]:=REDUCED3[J+1,0];
              FOURS[INDEX4,5]:=REDUCED3[J+1,1];
              FOURS[INDEX4,6]:=REDUCED3[J+1,2];
              FOURS[INDEX4,7]:=REDUCED3[J+1,3];
              FOURS[INDEX4,8]:=REDUCED3[1,4];
              FOURS[INDEX4,9]:=REDUCED3[1,5]:
              FOURS[INDEX4,10]:=(REDUCED3[J+1,0]-REDUCED3[1,0]);
              FOURS[INDEX4,11]:=0;
              REDUCED3[1,6]:=1;
              REDUCED3[J+1.6]:=1:
              INDEX4:=INDEX4+1;
```

```
END;
  END:
PRIME4:=INDEX4:
FOR I:=0 TO PRIME3-1 DO
    IF REDUCED3[1,6]=0 THEN
      BEGIN
        FOR K:=0 TO 11 DO
          BEGIN
            FOURS[PRIME4,K]:=0;
        FOURS[PRIME4,4]:=REDUCED3[1,0];
        FOURS[PRIME4,5]:=REDUCED3[1,1];
         FOURS[PRIME4,6]:=REDUCED3[1,2];
         FOURS[PRIME4,7]:=REDUCED3[1,3];
         FOURS[PRIME4,8]:=REDUCED3[1,4];
        FOURS[PRIME4,9]:=REDUCED3[1,5];
        PRIME4:=PRIME4+1;
DELIMINATE4(FOURS, INDEX4, PRIME4)
END: (*PROCEDURE SORT4*)
PROCEDURE PRIMEONE (REDUCED4: HOLDER6; POSITION, PRIMES: INTEGER);
FORWARD:
* PROCEDURE DELIMINATE4 - see PROCEDURE ELIMINATE3.
PROCEDURE DELIMINATE4:
  TOTALS: ARRAY[0..15] OF INTEGER:
  REDUCED4: HOLDER6;
  SUM, POINTT, POSITION, MATCHES, PRIMES, FLAG, K: INTEGER;
BEGIN(*PROCEDURE DELIMINATE4*)
  POINTT:=0;
  POSITION: =0;
```

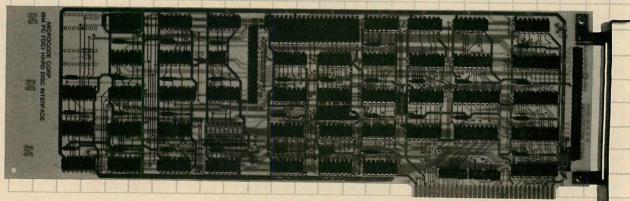
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### SIMPLE CIRCUITS

```
SUM: =0;
TOTALS[0]:=0;
IF (PRIME4=1) THEN
   FOR I:=0 TO 11 DO
    BEGIN
      REDUCED4[0,1]:=FOURS[0,1];
   POSITION: =POSITION+1;
 END
ELSE FOR I:=0 TO INDEX4-1 DO
  BEGIN
   FOR K:=0 TO 10 DO
      BEGIN
        SUM: =SUM+FOURS[I,K];
      END;
    FOR J:=0 TO POINTT DO
        IF SUM=TOTALS[J] THEN
        FLAG:=1;
      END:
    IF FLAG=0 THEN
        FOR K:=0 TO 11 DO
          BEGIN
            REDUCED4[POSITION,K]:=FOURS[I,K];
        TOTALS[POINTT+1]:=SUM;
        POSITION: =POSITION+1;
        POINTT: =POINTT+1;
     END;
   FLAG: =0;
   SUM:=0;
  END;
  PRIMES: = POSITION:
  FOR I:=INDEX4 TO PRIME4-1 DO
      FOR K:=0 TO 11 DO
          REDUCED4[PRIMES,K]:=FOURS[I,K];
      PRIMES: =PRIMES+1;
```

```
PRIMEONE (REDUCED4, POSITION, PRIMES)
END; (*PROCEDURE DELIMINATE4*)
PROCEDURE PRIMETWO (REDUCED4: HOLDER6; PRIMES: INTEGER; TARRAY: HOLDER7);
* PROCEDURE PRIMEONE begins by copying the output columns of OUTMORE
* from TABLE2 into NEWTABLE and then changing the output columns to
* logic O wherever there was a DON'T CARE condition. At this point
\star we have used the DON'T CARES to generate our reduced groupings as
* in Karnaugh mapping and we don't want to use them as essential
\star terms in our final reduction, therefore they are removed. Our
* FOURS array looks like this:
* COLUMN: 1 2 3 4 5 6 7 8 9 10 11
* ROW 1 0 2 8 10 4 12 6 14 2 4 8
* ROW 2
        0 8 2 10 2 4
* ROW 3
* Columns 1-4 and 5-8 are used when a reduction is composed of 8 \,
* minterms. If a reduction contains only 4 minterms then only
\star columns 5-8 are used. Likewise, if a reduced term contains only 2
\star minterms they are contained in columns 7 and 8. Columns 8-10
* reflect the power of 2 difference which was used to calculate the
* reduced term. PRIMEONE needs to know which values are valid and
* which locations are unimportant. Based on the number of twos diff-
* erences in the table, an arbitrary numeric value of 20 is used to
* fill in all empty COLUMN, ROW locations. PRIMEONE now goes back
* into the REDUCED4 array looking for the decimal equivalent of all
* DON'T CARE statements and also changes their value to 20. This
 insures that they won't be utilized in any final prime implicant.
* Each decimal value in REDUCED4 is checked to see if it is unique or *
* not. This indicates which rows are essential to the reduction. A *
* totaling array TARRAY is generated which contains a listing of each *
* decimal value in REDUCED4 and its frequency of occurrence.
* last data manipulation PRIMEONE performs is to remove all duplicate *
```

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### SIMPLE CIRCUITS

```
* valid decimal (minterm) equivalents from REDUCED4. Two things
* remain: REDUCED4, which now contains only unique decimal
\star (minterm) equivalent values, and the TARRAY, which tells us which
* row in REDUCED4 must be used because it contains the most terms.
PROCEDURE PRIMEONE:
VAR
  TABLENEW: ARRAY[0..15] OF ARRAY[0..2] OF INTEGER;
  TERMS.COLUMN.INDEXER: INTEGER:
  TARRAY: HOLDER7;
BEGIN (*PROCEDURE PRIMEONE*)
  COLUMN: =OUTINDEX-4;
  INDEXER: =0;
  FOR I:=0 TO LIMIT DO
      TABLENEW[I,0]:=TABLE2[I,4];
      TABLENEW[I,1]:=TABLE2[I,5];
      TABLENEW[1,2]:=TABLE2[1,6];
  FOR P:=0 TO COUNT-1 DO
      TABLENEW[STORAGE[P],0]:=0;
      TABLENEW[STORAGE[P],1]:=0;
      TABLENEW[STORAGE[P],2]:=0;
  FOR I:=0 TO PRIMES-1 00
    BEGIN
      IF REDUCED4[1,10]>0 THEN TERMS:=0
        ELSE IF REDUCED4[1,9]>0 THEN TERMS:=3
          ELSE IF REDUCED4[1,8]>0 THEN TERMS:=5
           ELSE TERMS: =6;
      IF TERMS>0 THEN
       FOR P:=0 TO TERMS DO
          BEGIN
            REDUCED4[I,P]:=20;
          END;
    FOR I:=0 TO LIMIT DO
      BEGIN
        IF TABLENEW[I, COLUMN] = 0 THEN
```

```
BEGIN
        FOR P:=0 TO PRIMES-1 DO
          REGIN
            FOR J:=0 TO 7 DO
              BEGIN
                IF REDUCED4[P,J]=I THEN
                  REDUCED4[P,J]:=20;
              END:
          END:
      FND .
TTL.PAS -- printed on 10-17-1983 at 12:56:27 -- Page 16
    FOR L:=0 TO PRIMES-1 DO
        FOR K:=0 TO 7 DO
         BEGIN
           FOR J:=0 TO PRIMES-1 DO
              BEGIN
                FOR I:=0 TO 7 DO
                  BEGIN
                    IF REDUCED4[J,I]=REDUCED4[L,K] THEN
                    INDEXER: = INDEXER+1;
                 END;
             END;
            IF INDEXER=1 THEN
              TARRAY[L,0]:=1
            ELSE TARRAY[L,0]:=0;
           INDEXER: =0:
         END:
     END;
   FOR L:=0 TO PRIMES-1 DO
      BEGIN
        IF TARRAY[L,0]=1 THEN
           FOR K:=0 TO 7 DO
             BEGIN
               FOR J:=0 TO PRIMES-1 DO
```

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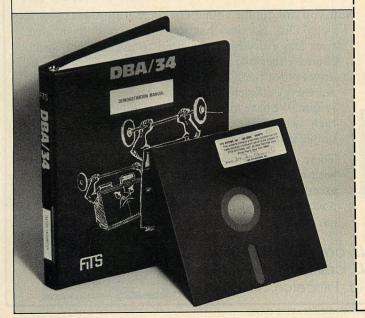
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### SIMPLE CIRCUITS

```
REGIN
                 FOR I:=0 TO 7 DO
                   BEGIN
                     IF REDUCED4[J, I]=REDUCED4[L,K] THEN
                       IF TARRAY[J,0]=0 THEN
                         REDUCED4[J,I]:=20;
                END:
            END;
        END:
PRIMETWO (REDUCED4, PRIMES, TARRAY)
END: (*PROCEDURE PRIMEONE*)
PROCEDURE PRINTTWO(REDUCED4: HOLDER6; TARRAY: HOLDER7; PRIMES: INTEGER);
* PROCEDURE PRIMETWO searches TARRAY for the decimal value which has *
* in the REDUCED4 array which will be used as a prime implicant.
* Having chosen the ROW, all of its terms are eliminated by being set
* equal to 20 hereby eliminating them from being used in any sub-
* sequent passes through the array. The totals in TARRAY are updated *
  for a similar reason.
*************************
PROCEDURE PRIMETWO:
 ELEMCOUNT, FLAG, TEMP, S, T: INTEGER;
BEGIN (*PROCEDURE PRIMETWO*)
 ELEMCOUNT: =0;
 FOR L:=0 TO PRIMES-1 DO
   BEGIN
     IF TARRAY[L,0]=0 THEN
         FOR K:=0 TO 7 DO
          BEGIN
            IF REDUCED4[L,K]<16 THEN
            ELEMCOUNT: =ELEMCOUNT+1;
          END:
         TARRAY[L,1]:=ELEMCOUNT;
```

```
FLEMCOUNT: =0:
  END:
END;
FI AG: =1:
TEMP:=0:
REPEAT
  FOR I:=0 TO PRIMES-1 DO
    REGIN
      IF TARRAY[I.0]=0 THEN
        REGIN
          IF TARRAY[TEMP, 1] < TARRAY[I, 1] THEN
            TEMP: =I:
       FND.
   FND .
  IF TARRAY[TEMP,1]>0 THEN
    TARRAY[TEMP.0]:=1:
  TARRAY[TEMP,1]:=0;
  FOR I:=0 TO 7 DO
    REGIN
      FOR J:=0 TO PRIMES-1 DO
        BEGIN
          FOR K:=0 TO 7 DO
            BEGIN
              IF REDUCED4[TEMP, I]=REDUCED4[J,K] THEN
                IF TARRAY[J,0]=0 THEN
                  REDUCED4[J,K]:=20;
            END:
        END;
    END:
  FI AG . = 0 .
  ELEMCOUNT:=0:
  FOR L:=0 TO PRIMES-1 DO
    BEGIN
      IF TARRAY[L, 0]=0 THEN
        BEGIN
          FOR K:=0 TO 7 DO
            BEGIN
              IF REDUCED4[L,K]<16 THEN
              ELEMCOUNT: =ELEMCOUNT+1;
          TARRAY[L,1]:=ELEMCOUNT;
```



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### SIMPLE CIRCUITS

```
FLAG:=FLAG+ELEMCOUNT;
                 ELEMCOUNT: =0;
              END:
          END;
        UNTIL FLAG=0:
PRINTTWO (REDUCED4, TARRAY, PRIMES);
END; (*PROCEDURE PRIMETWO*)
* PROCEDURE PRINTTWO builds TABLECOPY which will contain all the
* information needed to output the minimal reduction. CONUM is set
* equal to "X", "Y", or "Z" depending on which output column is being *
* currently calculated. Using TARRAY a unique decimal value is found *
st and used as an index into the REDUCED4 array. This tells us which st
* minterm is being chosen. A check is done on the ROW, COLUMN's 8,9, ^{\circ}
* and 10 to see which digit locations (powers of 2) have been
* eliminated. If a digit location has been eliminated then its value *
* location in the minterm is changed to a 0, i.e. if minterm 1101 had *
* been chosen but during the reduction digit locations 4 and 0 had *
\star been reduced, then TALBLECOPY's minterm value would be changed to
* reflect this reduction - 1000. Output is generated by a simple
* location by location check for ones and zeros with a 1 indicating a *
 positive literal (A) and a O indicating its compliment (A'), for
PROCEDURE PRINTTWO;
  TABLECOPY: ARRAY[0..15] OF ARRAY[0..4] OF INTEGER;
  FLAG, DECIMAL: INTEGER;
  CONUM: CHAR:
BEGIN(*PROCEDURE PRINTTWO*)
  IF OUTINDEX=4 THEN
    CONUM: = 'X'
  ELSE IF OUTINDEX=5 THEN
   CONUM: = 'Y'
  ELSE CONUM: = 'Z';
  FOR I:=0 TO LIMIT DO
      TABLECOPY[I,0]:=TABLE2[I,0];
      TABLECOPY[I,1]:=TABLE2[I,1];
```

```
TABLECOPY[1,2]:=TABLE2[1,2];
    TABLECOPY[1,3]:=TABLE2[1,3];
    TABLECOPY[1,4]:=0;
FOR I:=0 TO PRIMES-1 DO
 BEGIN
   DECIMAL: =0;
    IF TARRAY[I,0]=1 THEN
     BEGIN
        FOR K:=0 TO 7 DO
          BEGIN
            IF REDUCED4[I,K]<16 THEN
             DECIMAL: =REDUCED4[1,K];
        TABLECOPY[DECIMAL, 4]:=1;
        FOR J:=8 TO 10 DO
          BEGIN
            IF REDUCED4[I.J]=1 THEN
             TABLECOPY[DECIMAL,3]:=5
            ELSE IF REDUCED4[1,J]=2 THEN
              TABLECOPY[DECIMAL,2]:=5
              ELSE IF REDUCED4[I,J]=4 THEN
                TABLECOPY[DECIMAL,1]:=5
                  ELSE IF REDUCED4[I,J]=8 THEN
                    TABLECOPY[DECIMAL, 0]:=5
       END;
 END;
FLAG: =0;
WRITE (CONUM, ' = ');
FOR I:=0 TO LIMIT DO
    IF TABLECOPY[1,4]=1 THEN
        IF FLAG=1 THEN WRITE(' + ');
        IF TABLECOPY[1,3]=0 THEN
          WRITE ('A'''
        ELSE IF TABLECOPY[1,3]=1 THEN
        WRITE('A');
IF LITERALS>1 THEN
```

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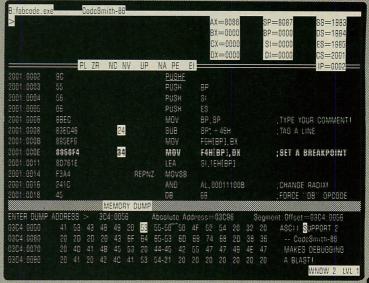
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### ■ How It Works...

Non programmers use Levels I and II. Level I consists of:

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- · A powerful, fast sort capability.

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Level III — Database modules for programmer use.

### COMPARISON OF POPULAR DATA BASE MANAGEMENT PROGRAMS

					The second second
	The B.O.S.S.	dBase™ II	TIM™ III	Condor™ 20	Data- Star™
Multi-user network	Yes	No	No	No	No
Menu driven	Yes	No	Yes	Yes	Yes
Files open on line	8	2	N/A	2	1
Maximum records/file	100,000,000	65,600	32,800	32,800	32,800
Maximum bytes/record	10,000	1,000	2,400	1,000	255
User must be programmer	No	Yes	No	No	No
Maximum number of index	xes 15	1	1	1	.1

(Data are taken from most recent versions of programs available to American Planning Corporation, Alexandria, VA)

### ■ Advanced Features

Experienced analysts and programmers use all levels to create sophisticated business application programs.

The B.O.S.S. provides analysts and programmers with a broad and varied set of functions patterned after mainframe software development tools. Large and complex programs are created easily and in record time.

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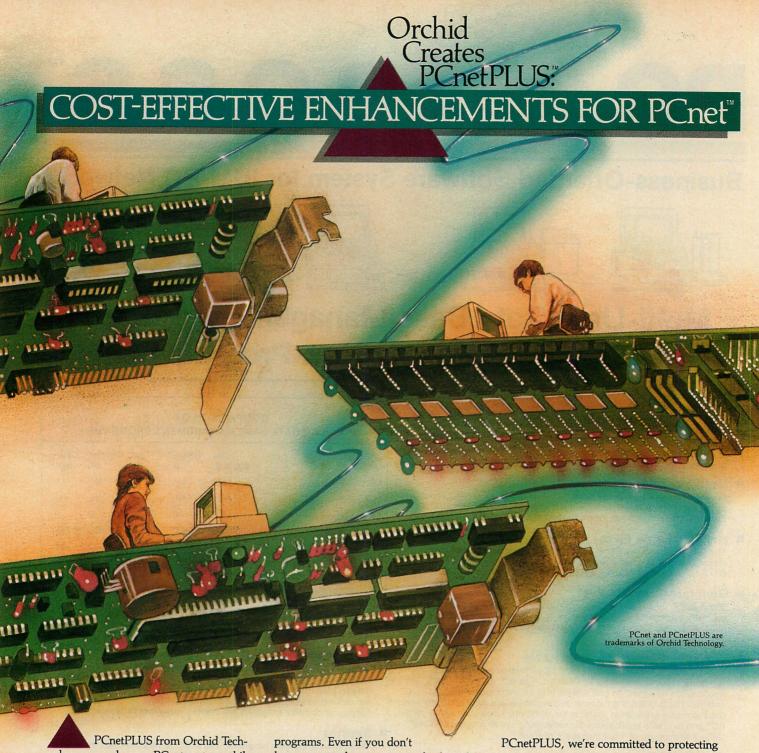
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### SIMPLE CIRCUITS

```
IF TABLECOPY[1,2]=0 THEN
              WRITE('B''')
             ELSE IF TABLECOPY[1,2]=1 THEN
              WRITE ('B'):
             IF LITERALS>2 THEN
              BEGIN
                IF TABLECOPY[I,1]=0 THEN
                  WRITE('C'''
                 ELSE IF TABLECOPY[1,1]=1 THEN
                  WRITE ('C');
                 IF LITERALS>3 THEN
                  REGIN
                    IF TABLECOPY[I,0]=0 THEN
                      WRITE ('D''')
                    ELSE IF TABLECOPY[I,0]=1 THEN
                      WRITE('D'):
                  END.
              END:
           END:
         FI AG: =1:
     END;
   END:
   WRITELN:
FND . (*PROCEDURE PRINTTWO*)
* PROCEDURE PRINTIT prints the truth table for the TTL circuit
* being tested. This includes inputs sent and the output results
* received from the circuit. Table formation is accomplished by
* referencing an array TAG which contains the literals(A,B,C,D,X,Y,Z) \star
* using the input variable LITERALS and the output variable OUTMORE. *
\star A simple cross-reference check is performed between STORAGE with
* TABLE. Where there is a match the output truth table column is
* changed to an "X" to indicate the presence of DON'T CARES.
PROCEDURE PRINTIT;
 TAG: ARRAY[0..6] OF CHAR;
BEGIN(*PROCEDURE PRINTIT*)
 FOR L:=1 TO 30 DO
```

```
TAG[0]:='D';
TAG[1]:='C':
TAG[2]:='B';
TAG[3]:='A':
TAG[4] := 'X' :
TAG[5]:='Y':
TAG[6]:='Z':
FOR J:=(4-LITERALS) TO (3+OUTMORE) DO
   WRITE (TAGE 1)
 END:
 WRITELN:
FOR J:=(4-LITERALS) TO (3+OUTMORE) DO
 BEGIN
   WRITE('----');
 END:
WRITELN:
FOR I:=0 TO LIMIT DO
 REGIN
   FOR P:=0 TO COUNT-1 DO
    BEGIN
       IF STORAGE[P]=I THEN TABLE[I,4]:=4;
        IF STORAGE[P]=I THEN TABLE[I,5]:=4;
        IF STORAGE[P]=I THEN TABLE[I,6]:=4;
     END:
    FOR J:=(4-LITERALS) TO (3+OUTMORE) DO
       EGIN

IF TABLE[I,J]=4 THEN WRITE('X','
');
     BEGIN
         ELSE WRITE(TABLE[I,J]:1,
        FND:
      WRITELN;
   END:
  WRITELN:
END; (*PROCEDURE PRINTIT*)
BEGIN (*MAIN PROGRAM*)
 INFORM;
  STEP;
END. (*MAIN PROGRAM*)
```

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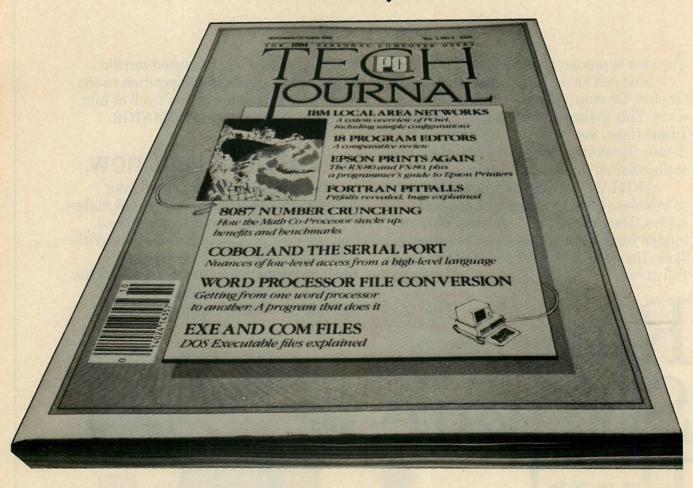
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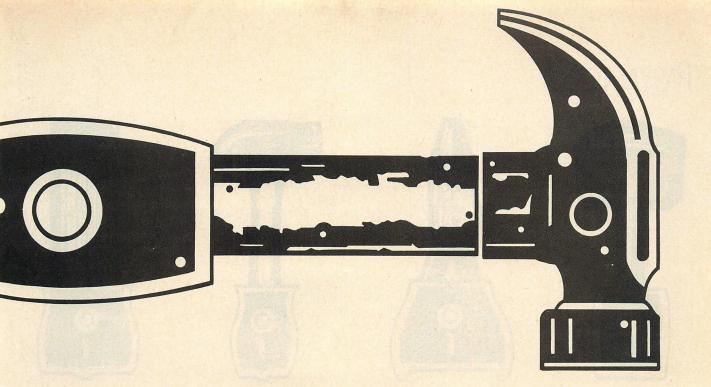
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he IBM Pascal Compiler is a complete implementation of Pascal, extended to include the ability to use and maintain libraries of useful procedures (through units), a "super array" type designed to facilitate string manipulation, and many other features not available in the standard Pascal definition.

While IBM Pascal provides the programmer with more capabilities than many other Pascal compilers, it still lacks many useful, simple-to-implement functions and procedures. For example, there are no built-in functions for finding the maximum of two numbers, extracting characters from a string, or converting the numeric representation of a date to its string equivalent. Also, IBM Pascal does not provide functions for controlling display attributes, cursor location, scrolling, or for reading the DOS command line.

Blaise Computing's Pascal Application Development Tools greatly enhance the usefulness of IBM Pascal. This package provides a strong base on which to build a comprehensive library of programmers' tools. Blaise Computing has made use of IBM Pas-

cal's \$INCLUDE compilation instruction, which allows programs (or groups of functions and procedures) saved in .OBJ format to be linked with the program being compiled.

Although both source (.PAS) and object (.OBJ) code are provided for most of the Pascal Tools, only the .OBJ files are needed during compilation. However, it is helpful to have the source code on hand because it can provide a clear and precise understanding of how each tool works.

This set of tools has been designed for use by professional software developers. The tools are intended for programmers who plan to use IBM Pascal in their daily work, but who do not want to spend the time or effort that is necessary to build even a minimum tool kit.

The Pascal Tools package includes a reference manual, two diskettes, and several quick reference sheets. The manual is divided into an overview, sections describing each group of tools, sample programs with comments, and an explanation of linking tools into Pascal programs.

One diskette contains the source code for all the tools; the other holds the object code. Also included on the second diskette is a program that can be used to copy the tools onto anoth-

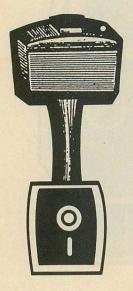
# Pascal Tools Review

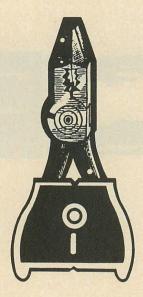
A package of tools that helps fill the gaps in the functions offered by the IBM Pascal Compiler

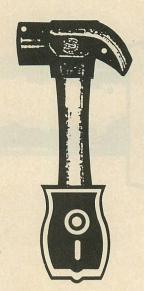
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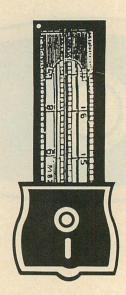
Arthur Gleckler is a senior at the Gilman School in Baltimore.

### PASCALTOOLS









er diskette automatically.

The quick reference sheets are printed on one side and designed to fit in the IBM Pascal manual. A brief description of each tool is given, including its effects and the type of parameter passed and result returned.

### THE TOOLS

Table 1 gives a brief description of each of the tools included in the Pascal Tools package. These tools are divided into six basic groups, which are implemented using IBM Pascal units. Each function or procedure is identi-

fied with a group by a two-character extension. The six groups are: Basic Intrinsic Functions

(TOOLSBB)

String Manipulation Routines (STRINGZZ)

(SIRINGZZ)

Screen Handling Procedures (SCREENVV)

Fast Forms Utilities

(FFORMSUU)

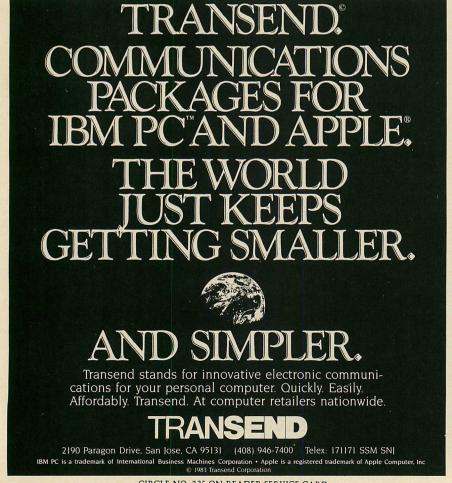
Graphics Interface

(GRAPHGG)

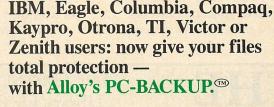
Application Routines (APPLIBXX)

Each of these well-designed tools addresses a specific need in a very general way. For example, a single procedure (SCROLLVV) can be used to scroll text up or down within any window, setting the display attributes on the line left blank after scrolling. Blaise Computing chose to include all necessary operations for scrolling in one procedure, which helps to reduce confusion and increases the flexibility of this tool. This approach has been used throughout the package, resulting in a consistent and flexible set of programmers' aids.

The Graphics Interface (GRAPHGG) provides a convenient way to access the IBM graphics card through Pascal. Its graphics vocabulary is certainly not as extensive as BASIC's, but it is adequate for most applications. Unfortunately, the speed of the line-drawing functions



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### PASCALTOOLS

in Pascal Tools is not impressive.

When the LINEGG procedure is used to draw a line, the drawing point moves at a crawling pace; this is unacceptable. It seems as if the line-drawing routines have been written in pure Pascal, using the tools'

PTWRITGG function to set one point at a time. Perhaps it would

have been better to have written the entire line-drawing routine in assembly language, coding only the Pascalto-machine-language interface in Pascal. This change would significantly increase the program's drawing speed and would therefore make the graphics tools truly useful.

The COMLINXX and CPAR-

SEXX procedures from the Applica-

detailed description of CPARSEXX would go on for pages; suffice it to say that this procedure saves time and is an excellent example of the overall quality of the Pascal Tools package.

tions Routines unit deserve special note. COMLINXX returns the command line last typed from DOS. For example, if the command

### transfer fileA fileB

is issued, and "transfer" is the name of a Pascal program, COMLINXX returns the string

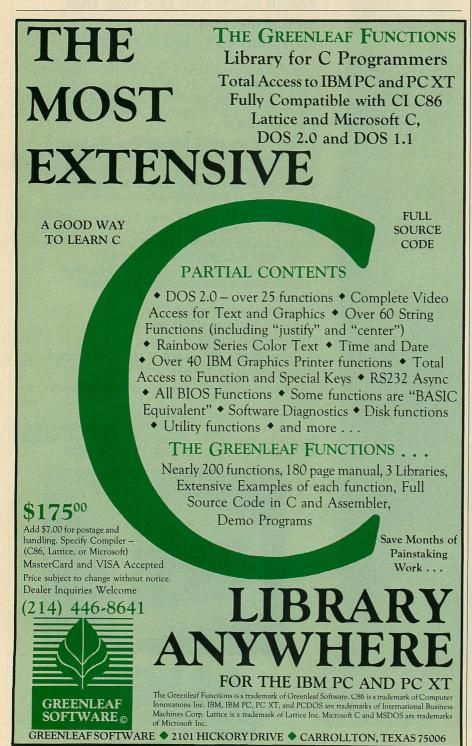
### fileA fileB

This procedure allows simple utilities and other programs to rely on DOS to take care of the work, thus avoiding interactive input. In the above example, the transfer program never has to prompt the user or execute a READLN instruction.

Using COMLINXX, however, leaves the program (and therefore the programmer) with the tasks of hunting for delimiters (space, commas, and other punctuation), tokenizing words, and dealing with defaults—not always trivial tasks. Blaise Computing provides the CPARSEXX procedure to help with these tasks.

CPARSEXX handles all the necessary command-line parsing functions. It supports an extremely generalized and flexible syntax of position-independent keywords and options. CPARSEXX checks command-line tokens and parameters passed to the procedure for correct syntax; returns information on the next keyword entry (a keyword, possibly followed by several options); and returns the remainder of the command line (which has not yet been parsed) as a string.

A detailed description of CPAR-SEXX would go on for pages (indeed,



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### PASCALTOOLS

four packed pages of the manual are devoted to this tool alone); suffice it to say that this procedure is an excellent example of the overall quality of the Pascal Tools package and should save hours of programming time.

### LINKING

The Pascal Tools make full use of IBM Pascal's units feature; the linking process is therefore relatively sim-

ple and straightforward. In order to use a tool in a Pascal program, the user simply enters the \$INCLUDE and USES commands with lists of all the units to be used. Note that some units in the Pascal Tools make use of other units; however, only units used directly by the program that is being compiled must appear after \$INCLUDE and USES (see figure 1).

Once a program using the Pascal

Tools has been successfully compiled, the resulting object code must be connected to the object code of each unit of the tools which was used. This connection is made through the use of the DOS LINK program. When using this program, the programmer must link all units that are used in the program, whether those units are used directly or whether they are used indirectly through other units.

### SAMPLE PROGRAMS

Four sample programs are included with the package to illustrate the use of the tools in Pascal programs. The Header program displays a message typed at DOS command level in a graphics border; Random performs statistical calculations based on the output of the tools' pseudo-random number generator (RNDBB). Curmov allows the user full control of the cursor position through cursor keys, and Copies is a program to copy the contents of one file into another file.

All four programs are supplied in source- and object-code format and include excellent documentation.

### **DOCUMENTATION**

The documentation of the Pascal Tools leaves very little to speculation. All programs are fully documented in their source code and are written to take advantage of Pascal's structured, readable syntax. Each source file has an explanation of the tool's function, a description of all parameters passed to and returned from the functions and procedures, and the Blaise Computing copyright notice.

The Pascal Tools manual is a notebook of sixty pages, and explains every tool in detail. In addition, the manual includes listings of all four sample programs and a section on linking the tools into Pascal programs. A tutorial section explains how to set a work diskette, how to compile and link a sample program, and how to customize the tools programs. A short section on common errors is also included.

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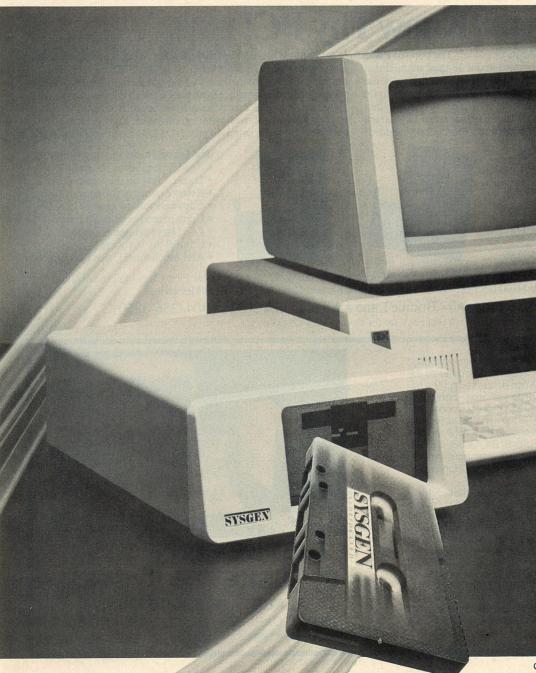
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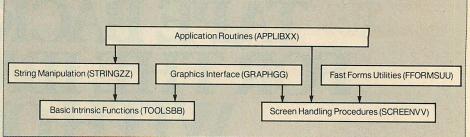
### PASCALTOOLS

owner] may distribute applications using the program [The Pascal Tools] at your discretion." No royalty fees or mention of Blaise Computing is required in the licensing agreement. This is important for programmers using the tools to develop applications programs for the PC marketplace.

### CONCLUSIONS

It is unfortunate that the linking process on the PC is so cumbersome. Although a batch file can be designed

Figure 1: Interdependencies of the Pascal Tools units. Lower units are required for the operation of higher units to which they are connected.



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### PASCALTOOLS

to take care of compiling and linking Pascal programs, the time required in the linking process can be painfully long. However, the linking process, unavoidable as it is, allows the programmer to develop a library of useful tools. The Pascal Tools use the linking capability of IBM Pascal to the fullest extent, thereby clearly demonstrating the power of this approach to programming.

The Pascal Tools should prove useful to the serious Pascal programmer because they provide features Pascal desperately needs and because they eliminate the need for the lengthy process of developing a library of tools from scratch. Blaise Computing Inc.

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Editor's note: Pascal Tools 2, which has recently been introduced, was not available for review at the time of this writing.

### Table 1: Functions and Procedures in the Pascal Tools Package

Basic Intrinsics (TOOLSBB)

MINBB returns the minimum of two integers MAXBB returns the maximum of two integers SIGNBB returns the sign of an integer **POWERBB** exponentiation function

RNDBB generates a random number between 0 and 1

String Functions (STRINGZZ)

returns the leftmost n characters of a string LEFT77 RIGHTZZ returns the rightmost n characters of a string SUBSTRZZ returns a substring of a string

replaces a substring of a string with a new substring MIDSTRZZ replaces a substring of a string with n copies of one character returns the position of one string within another **FILLZZ** 

INDEXZZ VERIFYZZ

returns the position of the first character of one string not found

in another string translates each character in a string to another character according to a table stored in a second string **XLATEZZ** 

CVTZZ converts a string according to a special code; can convert to upper

case, remove punctuation, etc.

**IVALZZ** returns the integer value of a numeric string DATEZZ returns the full string representation of the date (includes day of

TIMEZZ returns a string representation of the time (in AM/PM, not mili-

tary, format)

Screen Handling (SCREENVV)

RESETVV sets the current video screen attributes

MODEVV returns the current display mode, number of columns, and active

screen page number ACTPAGVV sets the currently active display page PAGSETVV sets the current display page

**PAGPOSVV** returns the current page number SCROLLVV scrolls text lines up or down in a window CLSVV clears the screen

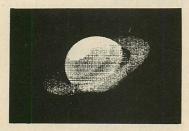
LOCVV

returns or changes the current cursor position CURSETVV changes the current cursor position

sets the display attributes at the cursor position and writes a char-

acter n times

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**CURSORVV** sets the current cursor size

returns the character and attributes at the current cursor posi-READVV

WRITEVV writes n copies of a character to the display

SCNWRTVV writes a character to the active display page using TTY conven-

Fast Forms Utilities (FFORMSUU)

**ERRMSGUU** 

sounds the system alarm (beeps the speaker) ALARMUU ABORTUU aborts the program and displays a message

displays a message at any screen position without moving the cur-

clears a section of text in the screen without changing its screen CLRMSGUU

attributes

INKEYUU PAUSEUU

waits for a single keypress and returns the key pressed displays a message and "Press any key to continue . . .", then

waits for a keypress

Graphics Interface (GRAPHGG)

sets the graphics or text mode including background and palette

sets the home plotting position **HSETGG** HREADGG returns the home plotting position PTWRITGG displays a colored dot at a point PTREADGG returns the color of a point

draws a straight line from one point to another

LINEGG **AMOVEGG** draws a straight line from the home plotting position to a point draws a straight line from one point to another using the home **RMOVEGG** 

plotting position as origin

**Application Routines (APPLIBXX)**PYESNOXX asks a yes/no que asks a yes/no question and returns a Boolean flag corresponding to

the answer given

displays a message, inputs a number, and checks for a valid num-**PRDUMXX** 

ber

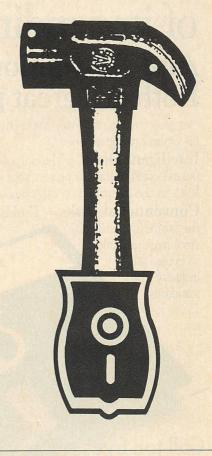
PRDLINXX displays a message, accepts a text answer, and returns false if a

carriage return is input

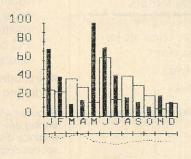
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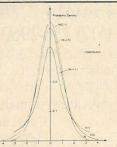
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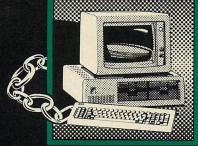
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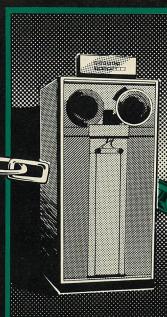
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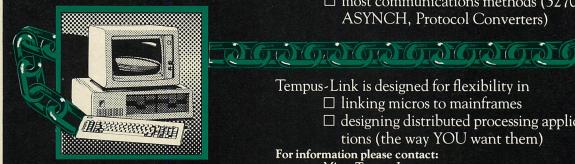




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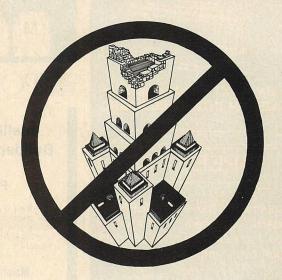
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# Compiled/Interpreted BASIC Check



NELSON FORD

Here's how to make a BASIC program work, whether it's interpreted or compiled

IBM's BASIC compiler and interpreter are designed so that a program written in interpreted BASIC can be easily compiled, without major syntactical or structural changes. However, there are areas in which incompatibilities between the two languages cause problems for the program developer. For example, while the IBM BASIC interpreter's USR statement can pass arguments to a subroutine, the IBM compiler's USR cannot, and must be replaced with different code when the program is to be compiled.

Although two versions of a program can be kept—one for the compiler and one for the interpreter—this method is unacceptable when frequent updates must be made. If two versions are kept, the programmer must update both copies of the program separately, possibly introducing errors and certainly complicating the process of program development. Here is a technique whereby only one version need be kept.

Ironically, the technique makes use of one of the inconsistencies be-

tween compiled and interpreted BA-SIC: While interpreted BASIC supports an ERASE statement to reclaim memory previously used to store arrays, compiled BASIC does not. The ERASE statement has no effect on an array in compiled BASIC. By setting up an array, ERASEing it, and looking at it again, a program can determine if it is interpreted or compiled.

In order to make this method clear, let's first look at an example of it in action (see listing 1).

In the program, the one-element array COMPILED is set up and initialized to TRUE. The computer is then instructed to ERASE the array. If the one element of COMPILED is still set to TRUE, the program knows that ERASE had no effect, and the program is therefore being run compiled. On the other hand, if the value of COMPILED has changed, the ERASE statement was effective, and the program is being interpreted.

The last two lines of the program actually perform the tests. If COMPILED (1) is TRUE, the message "COMPILED." is interpreted; if

COMPILED (1) is NOT TRUE, "INTERPRETED" is displayed.

Note that this program will generate a single error when compiled. The compiler will issue a warning error because it does not recognize the ERASE statement; however, it proceeds to generate code for the rest of the program despite this error. The compiled version of the program will not contain any code whatsoever for the ERASE statement, and the program will act as if the ERASE statement was never part of it.

Listing 2 highlights the difference in DIM statements between the two languages. While the BASIC interpreter allows variables or constants as arguments to DIM, as in

#### DIM students (number of students)

the basic compiler requires that the arguments be constants, as in

#### DIM students (1000)

Although an interpreted BASIC program that is intended to be compiled could use a constant value as the argument to DIM to prevent

#### LISTING 1 SIMPLE COMPILED/ INTERPRETED TEST PROGRAM

```
1000 ' Test Program for Nelson Ford's Compiled/Interpreted Check
1010 CLS
1020 TRUE = (1 = 1)
1030 DIM COMPILED (1)
1040 COMPILED (1) = TRUE
1050 ERASE COMPILED
1060 IF COMPILED (1) THEN PRINT "COMPILED."
1070 IF NOT COMPILED (1) THEN PRINT "INTERPRETED."
```

# LISTING 2 APPLICATION OF COMPILED/INTERPRETED TEST PROGRAM

```
1000 ' Sample Program for Nelson Ford's Compiled/Interpreted Check
1010 CLS
1020 TRUE = (1 = 1) 'set up compiled/interpreted check
```

```
1030 DIM COMPILED (1)
1040 COMPILED (1) = TRUE
1050 ERASE COMPILED
                          'ignore error in this line during compilation
1060 INPUT "How many numbers do you want to store"; NUMBERS
1070 ' note that the compiler does not allow variables as arguments to 1080 ' DIM, while the interpreter does; therefore, the next two lines
          DIM, while the interpreter does; therefore, the next two lines
           are needed; note also that 500 is an arbitrary maximum
1090 '
1100 IF COMPILED (1) THEN DIM NUMS (500)
1110 IF NOT COMPILED (1) THEN DIM NUMS (NUMBERS) 'ignore compiler error here
1120 FOR A = 1 TO NUMBERS
       PRINT A;".
1130
1140 INPUT NUMS (A)
1150 NEXT A
1160 LINE INPUT "Press enter to view the numbers you typed.";A$
1170 FOR A = 1 TO NUMBERS
        PRINT A:".
1180
        PRINT NUMS (A)
1190
1200 NEXT A
```

compatibility problems, this would be a memory-wasteful compromise. Using the method shown in the previous program, we can instruct the interpreted program to use the memory-conservative construction and the compiled program to use the only construction the compiler allows.

The function of this program is to store and display an array of numbers. The first thing the program does is to define and ERASE the COMPILED array exactly as in the previous program. Then it queries the user as to how many numbers are to be stored. Next, it determines whether the program is being interpreted or compiled. If the program is being interpreted, the NUMS array is set up to have exactly as many elements as the user has requested. If the program has been compiled, an array of 500 elements (an arbitrary maximum, high enough to insure that the array is large enough for any request) is dimensioned.

Note that two errors are generated when this program is compiled: one for the ERASE statement, as in the first program, and a second one for the DIM NUMS (NUMBERS.)

This technique for making programs portable between interpreted and compiled BASIC is very powerful, yet should be used with caution. The programmer should keep especially careful count of the number of error messages the compiler displays, for if a real program error should get lost among the intentional errors, serious problems could ensue.

Nelson Ford is director of reporting and forecasting systems for Daniel Industries in Houston, Texas. He is author of Business Graphics for the IBM PC.

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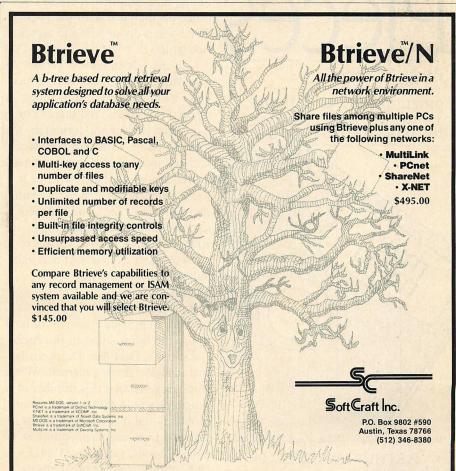
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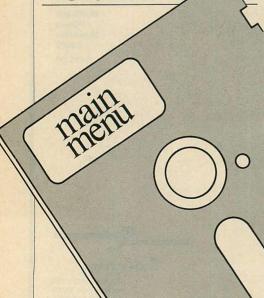


#### SOFTWAREREVIEW

# DE ASY Pieces

Peeks 'n Pokes:

programs and techniques
for programmers



ARTHUR A. GLECKLER

eeks 'n Pokes for the IBM Personal Computer, by Brett Salter, is a collection of programs and techniques for assembly language, BASIC, and Pascal programmers. It is organized as a tutorial, and covers such diverse topics as reading system configurations, programming serial ports, and using DOS and BIOS function calls.

The *Peeks 'n Pokes* package includes two basic types of information: how to access and modify system information, and how to perform DOS and BIOS function calls from BASIC and Pascal. Also included with the package are stand-alone utility programs that clear and reverse the screen, beep the speaker, switch monitors, display the date and time, and perform a top-of-form on the printer.

#### THE BOOK

Peeks 'n Pokes comes in a blue plastic folder with a 38-page book of techniques and documentation for the programs included with the package. The book is divided into 15 sections (see table 1).

In the "Definition of Terms" section, there is an explanation of bits, bytes, words, segmented memory, interrupts, I/O ports, and more. The discussion is clear and thorough, with one exception: Although hexadecimal and binary notation are referred to frequently, neither is defined in the chapter. Because most programmers who read *Peeks 'n Pokes* will understand both concepts, it is strange that Mr. Salter explains terms as elementary as *byte*, but does not explain binary notation.

#### THE PROGRAM

In order to provide examples of how to use the information in the *Peeks 'n Pokes* book, Data Base Decisions has included 58 sample programs. While it might seem that this number of programs would cause organizational problems and make the programs inconvenient to use, the opposite is true. A BASIC program, MENU, links all of the other programs to-

gether and provides a description of each (see figure 1). To execute any program, one merely types its name from the menu. The program is loaded into memory, and prompts for

BASIC program, called menu, links the 58 programs together and provides a description of each. To execute a program, one merely types that program's name from the menu.

any information that is needed. As soon as the program has finished its task, it waits for the enter key to be pressed, then returns to the main menu. All of the programs have been updated to work under DOS 2.0.

Figure 2 shows the menu of the DOS program, which is invoked from the main menu and provides examples of the usage of each DOS/BIOS function call in the PC.

The menu system is present to make the learning process easier. The advantage of having all the programs separate from one another is simply that it is much easier to add a small, independent program to your own than it is to extract a subroutine from a much larger program.

Every program runs independently of the menu program and is well-documented with REMark statements. Most of the programs are written and documented clearly enough that it is not necessary to refer to the *Peeks 'n Pokes* book.

A program to read the system configuration is included. Like the other programs, it works exactly as advertised, except: It misreads the configuration of the XT or the new PCs with 256K system boards. The configuration program always shows 64K installed on the system boards. However, Mr. Salter anticipated this for the XT. Next to the system board memory is a message: "\*\*\* Incorrect

for XT \*\*\*." Apparently, he is still figuring out how to write software to read this information correctly.

The configuration-reading programs in the Peeks 'n Pokes package should be particularly useful to programmers preparing to market their creations. Because a wide variety of hardware configurations exists in the PC and XT marketplace, programs must be designed to adapt to many different computer systems. Peeks 'n Pokes helps by explaining how to let a program find out what type of system it is running on. Programs are included to determine: the amount of memory installed; the number of parallel, serial, and game adapter ports: the number of disk drives; and the number and type of display(s) used.

One set of routines in this package will allow disk directory information to be read, which simplifies filehandling. For example, using these functions, one program might read the directory, sort it by filename, and display it as a menu, while another might detect and prevent possible Disk Full errors.

Peeks 'n Pokes provides routines for low-level machine access using IBM Pascal. Included are functions that duplicate BASIC's, PEEK, POKE, INP, and OUT instructions. There is also a routine that allows using DOS and BIOS function calls through Pascal. Very brief programs are included to demonstrate these functions. By providing access to DOS and BIOS. Peeks 'n Pokes greatly expands IBM Pascal's power.

very program will run independently of I the menu program and is well-documented with REMark statements.

In addition to the tutorial programs, there are several stand-alone utilities designed to be used from DOS. There are programs to clear the screen and switch monitors, although

#### Table 1: Peeks 'n Pokes Contents

1. Definition of Terms Explains bits, bytes, words, PEEK, POKE, segments, INP, and OUT

2. Getting Started Making a backup copy of Peeks 'n Pokes; general in-

formation on each program 3. System Configuration Reading and modifying system information: number

of drives, monitor type, system board memory size, number of parallel printer adapters, number of game adapters, and number of serial adapters

4. Unprotecting Basic How to unlock a BASIC program saved in protected

5. Keyboard Reading and changing the current status of the keyboard

6. Video Monitor Reading and changing display information and attri-

7. Disk Read the status of the disk drives 8. Parallel Printer Reading and using the parallel printer ports

9. Communications Reading and using the serial ports

10. DOS/BIOS Function calls Using DOS/BIOS functions through BASIC and Pas-

11. Disk Directory and Space Read disk directory and free space on disk through

12. Interpretive BASIC Information on BASIC programs: starting and ending memory locations, current line number, location of

variables in memory, etc. 13. Miscellaneous Using the speaker, reading the system time, and free memory locations for program information exchange

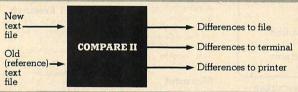
14. Finding Peeks 'n Pokes How to find more important memory locations, methods of accessing peripherals, etc

15. Peeking with Pascal Adding PEEK, POKE, INP, and OUT functions to Pas-

similar functions have been included with the DOS 2.0. Peeks 'n Pokes also includes programs to perform a topof-form on the printer, reverse the

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# 58 EASY PIECES

colors of characters on the screen, display the date and time, beep the speaker, and wait for a keypress.

Peeks 'n Pokes is a useful package for assembly language, BASIC, and Pascal PC programmers. While much of the information included in the package can be found, with effort, in IBM's DOS, BASIC, and Technical Reference manuals, this package organizes the most useful information in one handy reference guide. Peeks 'n Pokes is certainly worth its \$30 price.

Peeks 'n Pokes for the IBM Personal Computer is available from Data Base Decisions, 14 Bonnie Lane, Atlanta, GA 30328, 404-256-3860. CIRCLE 488 ON READER SERVICE CARD

#### Figure 2: DOS/BIOS function calls menu

\*\*\* DOS/BIOS Function Calls \*\*\*

- 2 Read system configuration
- 3 Read amount of memory
- 4 Start cassette BASIC
- 5 Boot system
- 6 Input char with no echo
- 7 Clear keyboard & wait for input
- 8 Change default disk
- 9 Get default disk
- 10 Read date
- 11 Change date
- 12 Read time
- 13 Change time 14 - Turn disk verify on
- 15 Turn disk verify off
- 16 Initialize RS-232 port(s) 17 - Write char to RS-232 port(s)
- 18 Read char from RS-232 port(s)
- 19 Get RS-232 status
- 20 Get keyboard status
- 21 Initialize printer(s)
- 22 Print char on printer(s)
- 23 Read printer status 24 - Change video mode
- 25 Change cursor type
- 26 Change cursor position
- 27 Read cursor position & type
- 28 Read light pen
- 29 Select display page
- 30 Scroll screen up 31 - Scroll screen down
- 32 Read attribute/char from screen
- 33 Write attribute/char to screen 34 - Write character to screen
- 35 Read video status

Function number (0 to return to menu)?

#### Figure 1: Peeks 'n Pokes main menu

Peeks 'n Pokes For the IBM Personal Computer Copyright (C) 1982 Data Base Decisions

COM

Version 2.0

Program Description

CONFIG - System Configuration - Unprotect BASIC programs UNP KEYREAD - Read keyboard status

KEYSET - Set keyboard KEYPLUG - Plug data into keyboard KEYOFF - Turn keyboard off/on

- Read video status CRT CRTSWAP - Swap CRT displays

CRTDEMO - Poke colors & characters - Read disk status DISK LPT

- Read parallel printer status CALC

nns - DOS/BIOS function calls READT - Read file directory SPACEI - Space used/left on disk BASIC - Interpretive BASIC MISC - Miscellaneous functions

Program Description

BSAVE - BSAVE files for COMPARE COMPARE - Compare BSAVE files - Calculate peeks and pokes

LPTSWAP - Swap parallel printers

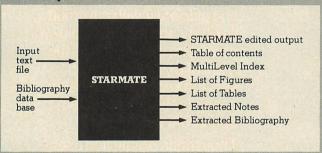
COMSWAP - Swap RS-232 adapters

- Read RS-232 adapter status

Enter program name (press return to end):

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WATSOFT Products Inc. 158 University Ave. W., Waterloo, Ontario N2I 3F9

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CIRCLE NO. 261 ON READER SERVICE CARD

#### The Easiest Way To Get Your IBM PC **Talking With Your** IBM Host Is With A Renex **Protocol Convertor**



**Personal Computer** 

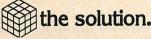
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# The best reason to choose mbp C rvour IBM/P

#### **GIBSON MIX Benchmark Results**

Calculated S-Profile (Representative COBOL statement mix)

#### **Execution time ratio**

mbp COBOL 1.00

Level II\*\* COBOL 4.08

Microsoft\*\*\* COBOL 6.18

R-M\*\*\* COBOL 8.26

The Gibson Mix Benchmark Results chart just about says it all, doesn't it? Compared with COBOL interpreters,



4 times faster.

mbp's COBOL Compiler executes programs at least four times faster. With mbp on your IBM/PC,\* applications that used to take four hours now take one.

Why? Because interpreters translate and execute a program one statement at a time, every time the program runs.

By comparison, mbp's COBOL Compiler generates machine language object code, so the entire program is translated only once. It then can be executed as

often as you want in a fast single step-with no retranslation.

#### Develop programs faster.

Bechtel, Chase, Citicorp, Connecticut Mutual, Sikorskycompanies that make their own comparative evaluationschose mbp. Certainly faster running speed was important to them, but that wasn't the only reason for the choice.

Here's a Connecticut Mutual spokesperson's comment: "...It took us approximately 5% the time to convert (COBOL) programs from the mainframe computer to mbp as it did to convert them to Microsoft's COBOL ... '

Put another way, mbp saved 95% of the conversion time.

#### mbp: the complete COBOL.

GSA certified to ANSI '74 Level II; a sophisticated Screen Management System (SMS) and an Interactive Symbolic De-Bug Package included standard; Multi-Keyed ISAM Structure; listing options allow source & object code, map & cross-reference checking; mbp has them all and much more.

After you compare mbp's advantages, compare it's price: \$500. Convinced?

128K system with hard disk required. \*IBM/PC is an IBM TM;

\*\*Level II is a Micro Focus TM; \*\*\*A Microsoft TM; \*\*\*\*A Ryan-McFarland TM.



# 4 times faster. \$50

Please send me complete mbp COBOL information and performance data with Gibson Mix results.

COMPANY\_

STATE

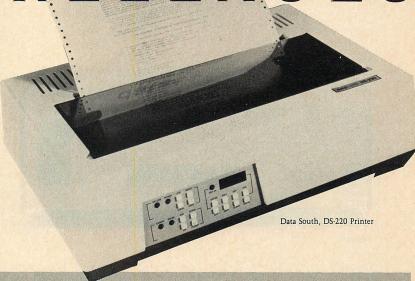
mbp Software & Systems Technology, Inc.

7700 Edgewater Drive, Suite 360 Oakland, CA 94621

Phone 415/632-1555

# TECH RELEASES

Hardware, software, and other developments for the PC



#### HARDWARE

Model EX 500P Line Conditioner from Exlin provides line regulation and noise suppression in a compact, portable enclosure. The unit maintains constant output voltage when input line voltage varies. \$375.

EXLIN
P.O. Box 178471
San Diego, CA 92117
619-571-3134
CIRCLE 408 ON READER SERVICE CARD

Kleen-Line® Conditioner from Electronic Specialists provides microcomputer protection and interference control. Features include sine wave output, quiet operation, added input spike suppression, and wideband pre-filtering. 250, 500, 1,000 and 2,000 watt ratings. From \$291.95.

ELECTRONIC
SPECIALISTS, INC.
P.O. Box 389
Natick, MA 01760
800-225-4876
CIRCLE 409 ON READER SERVICE CARD



The LVS 76.8 from Complexx Systems is a limited-distance modem that allows fast, long-distance data transmission over a broad range of switch-selectable bit rates. At its 76.8K bps maximum speed, LVS 76.8 can send data 16,250 feet (5,000 meters) on typical 22-gauge wire. \$650 for version with RS-232C interface; \$725 for the V.35 version.

COMPLEXX SYSTEMS, INC.
4930 Research Drive

4930 Research Drive Huntsville, AL 35805 CIRCLE 410 ON READER SERVICE CARD

Micromint's new

RTC-4 is a generalized fourchannel, time-activated programmable controller. Based on a TI microcomputer, the RTC-4 can accept daily or weekly programmable setpoints, display time of day and status, and independently switch outputs. It includes a LED display and associated drivers, a keypad with twenty keys, and a four-output relay switcher. \$122. Quantity discounts available.

MICROMINT INC.
561 Willow Ave.
Cedarhurst, NY 11516
516-374-6793
CIRCLE 411 ON READER SERVICE CARD

DS2 and DS2S are two new products from Byad in its DS series product line aimed at OEMs. DS2, which is available in two versions, is a coprocessing microcomputer system that plugs into the IBM PC to allow end users to run CP/M software or normal PC DOS software on the PC. The OEM version, DS2A, contains an additional operating system. DS2S is a board with all the capability

al operating system. DS2S is a board with all the capabilities of the DS2, but the serial port has been replaced by four synchronous/asynchronous ports. DS2—\$760. DS2A—\$1,000. DS2S—\$1,500.

BYAD INC. 95 W. Algonquin Rd. Arlington Heights, IL 60005

312-228-3400 CIRCLE 412 ON READER SERVICE CARD

From Capital Equipment Corp. comes the CEC 01000, an XT-compatible board that implements the complete IEEE-488 standard. A resident firmware interpreter acts as an extension to the IBM BASIC language interpreter and allows programs to be written using simple English-language statements, including Tektronix Standard Codes and Formats and Hewlett-Packard instrument programming strings. \$395. Quantity discounts available.

CAPITAL EQUIPMENT CORP.

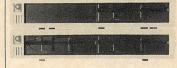
10 Evergreen Avenue Burlington, MA 01803 617-273-1818 CIRCLE 413 ON READER SERVICE CARD

Floppy Disk Services has introduced a new 8" double-sided disk drive, the FD-PC8, that adds 2.5 Mb on-line storage to IBM PCs. \$1,495.

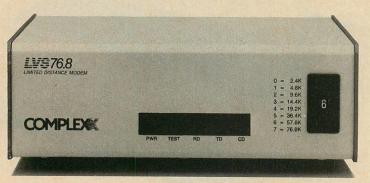
FLOPPY DISK SERVICES, INC.

741 Alexander Road Princeton, NJ 08540 609-799-4440 or 800-223-0306

CIRCLE 414 ON READER SERVICE CARD



Octacom is a multichannel RS-232 communications module for the PC from Star Gate Technologies. It allows up to eight terminal connections to a single module; supports standard COM1 and COM2 ports of PC DOS, and adds up to six additional ports for use with the multitude of serial devices for the IBM PC. \$495, 4 channel; \$545, 6 channel; \$595, 8 channel.





LVS 76.8

STAR GATE
TECHNOLOGIES
P.O. Box 764
Chesterland, OH 44026
216-292-5390
CIRCLE 415 ON READER SERVICE CARD

From Maynard Electronics come three new Winchester Hard Disc Drive Systems for the PC. All three systems are engineered to run on DOS 2.0 or other operating systems that use the XT hard disk system. All systems are equipped with a Maynard SandStar Card, a SandStar Hard Disc Controller Module, complete software, and cable. They are available in three configurations: with a SandStar Multifunction Card, SandStar Floppy Drive Controller Card, or the SandStar Memory Card. \$1,395.

MAYNARD
ELECTRONICS
400 Semoran Blvd.
The Greater Mall, Ste. 207
Casselberry, FL 32707
305-331-6402
CIRCLE 416 ON READER SERVICE CARD

**LABTECH-PC** is a materials-testing automation system from **Laboratory Tech-nologies Corp.** that is modular, features data acquisition, critical instrument control, display, analysis, and data storage. LABTECH hardware, TESTMATE, which

acquires data and provides instrument control, fits into a PC, XT, or IBM compatible. The software consists of operator-friendly MTAP software to ASTM standards and a choice of three TEST-MATES, all with general-purpose software to support key data acquisition and/or control functions. \$14,950.

LABORATORY
TECHNOLOGIES
CORP.
328 Broadway
Cambridge, MA 01239
617-497-1010
CIRCLE 417 ON READER SERVICE CARD

From Santa Clara Systems come Quick Disk, a disk cache system, a new line of internal hard disk drives, and upgrades of its 51/4-inch hard disk drives. Quick Disk is an external add-on memory of 128K to 1 megabyte. \$2,795 to \$8,595. Three configurations of internal disk drives are offered in kit form: 6 mega-bytes removable, \$2,095; 6 megabytes removable with a 51/4-inch, halfheight floppy drive, \$2,795; and 6 megabytes removable/ 6 megabytes fixed, \$2,995. The upgraded hard disk drives have 6, 12, or 18 megabytes of fixed disk storage, with 6 megabytes of storage on a removable 3.9inch cartridge. \$2,295 to \$5,056. SANTA CLARA

SYSTEMS
1680 Hartog Dr.
San Jose, CA 95131
408-287-4640
CIRCLE 418 ON READER SERVICE CARD

Datasouth Computer's DS220 multimode matrix printer has three printing capabilities: correspondence printing for word processing, draft quality for high speed data processing, and dot-addressable graphics. DS220 interfaces directly to the PC parallel interface by means of a special cable available from most PC dealers. It can also be interfaced to the PC's asynchronous communication card using standard RS-232 output. \$1,995.

DATASOUTH
COMPUTER CORP.
4216 Stuart Andrew Blvd.
Charlotte, NC 28210
704-523-8500
CIRCLE 419 ON READER SERVICE CARD

The MSI-VS01 Voice Synthesizer from Microcomputer Systems,

Inc. is designed for use with the PC or XT. The card produces a vocal message using the 64 available phonemes of the VOTRAX SC-01 Speech Synthesizer CMOS IC. The memory required for

vocal sequences resides in the RAM memory. \$175. MICROCOMPUTER SYSTEMS INC. 1814 Ryder Dr. Baton Rouge, LA 70808 504-769-2154 CIRCLE 420 ON READER SERVICE CARD

From Kaufman Research Manufacturing Inc. comes a modular protocol converter that can support many types of asynchronous devices on from one to eight channels. each with its own microprocessor. There are two models: 870 converts binary synchronous protocols, including SNA/SDLC, into asynchronous, emulating the IBM 3270 cluster controller. Model 871 converts Sperry Univac Uniscope protocol into asynchronous in emulation of the UTS 400. \$3395 for basic system; \$700 for each additional module.

MANUFACTURING
INC.
145 E. Dana St.
Mountain View, CA 94041
415-962-8811
CIRCLE 421 ON READER SERVICE CARD

KAUFMAN RESEARCH





The **OMR/25 System** is a high-speed, table-top optical mark reader that can be linked to the PC from **Cognitronics**. It is intended primarily for educational data entry applications, including in-house test scoring, attendance reporting, course scheduling, and grade reporting. The automatic feed can handle 200 documents from 2" x 4" to 9" x 12." \$11,500 with PC; \$8,500 without. COGNITRONICS

25 Crescent St. Stamford, CT 06906 800-243-2594 CIRCLE 422 ON READER SERVICE CARD



Datacopy's electronic digitizing camera,
Model 610, captures images of photos, documents, printed text, or three-dimensional objects and turns them into digital code. \$7,850.
Companion products are Model 110 Image Processing Interface, which includes capture software and is specifically designed for use

with the PC, \$795; and Model 90 Integrated Imaging System, which consists of models 610 and 110 and accessories that include camera power supply, camera stand, illumination, camera lens, and the necessary cables and service manual, \$9,945.

DATACOPY CORP.

1070 E. Meadow Circle
Palo Alto, CA 94303

415-493-3420
CIRCLE 423 ON READER SERVICE CARD

**Teleport 300** from **Teltone Corp.** is a smart modem that allows users to enter computer data from a remote touch-tone telephone without using a terminal or to accept standard computer-to-computer data transmissions. It is compatible with Bell 103 protocol. \$349.

TELTONE 10801 120th NE Kirkland, WA 98033 206-827-9626 CIRCLE 424 ON READER SERVICE CARD

The PC/8088 Component Personal Computer is an IBM-compatible single-board micro from Computer Systems.

Some PC-compatible features are: Intel 8088 CPU with option for 8087 co-processor; 64K RAM, expandable to 256K of parity-checked RAM; 32K EPROM memory

provision, DOS/BIOS, printer port. \$500 to \$925.

COMPUTER SYSTEMS
26401 Harper Ave.
St. Clair Shores, MI 48081
313-779-8709
CIRCLE 425 ON READER SERVICE CARD

DASCON-1 is a data acquisition and control system for the PC from MetraByte Corp. The analog and digital input/output board plugs directly into the PC permitting programmer access to twelve digital I/O lines, two analog outputs, and four differential analog inputs per board at a throughput of sixteen channels per second. Package also includes software, instruction manual, 37pin D connector, calibration resistors, card guide and oneyear warranty. \$485.

METRABYTE CORP. 254 Tosca Dr. Stoughton, MA 02072 617-344-1990 CIRCLE 426 ON READER SERVICE CARD

**Signalman Mark XII** is **Anchor Automation's** modem, which uses a standard RS-232 serial interface with a built-in cable. It comes equipped with two telephone jacks and cord, and is directly connected to a wall telephone outlet. \$399.

ANCHOR
AUTOMATION
6913 Valjean Ave.
Van Nuys, CA 91406
213-997-6493
CIRCLE 427 ON READER SERVICE CARD

Display Interface Corporation's HiFi Mouse

is based on new proprietary technology. Unlike many previous mice, it has no mechanical potentiometers, balls, or shafts. HiFi Mouse uses two sensory devices to detect the distance and direction of movement over a surface. An on-board microcomputer combines the speed and distance signals with direction indication to provide instructions for the movement of the cursor on the CRT screen. \$195; quantity discounts available.

DISPLAY INTERFACE CORP. 1770 Post Road, C.S. 3240 Milford, CT 06460 203-877-7661 CIRCLE 428 ON READER SERVICE CARD



**Ora Electronics' Data Spec** line of joysticks now includes an IBM plug-compatible joystick controller.



Model IB-XY-23 is designed to meet the tough demand of the commercial/industrial market. It has ultra linear potentiometers and an allmetal enclosure for maximum shielding and weight stability. \$69.95.

ORA ELECTRONICS 18215 Parthenia St. Northridge, CA 91325 213-701-5848 CIRCLE 429 ON READER SERVICE CARD

DATACAM I and DATACAM 35 are two color graphic recording cameras from **Photographic** Sciences. Both are designed for professional applications. Both cameras come in two sizes: <sup>12/13-inch</sup> and <sup>19/21-inch</sup>. For instant pictures, CRT graphics can be photographed on Polachrome 35mm film. \$545 to \$925.

PHOTOGRAPHIC SCIENCES CORP. P.O. Box 338 Webster, NY 14580 716-265-1600 CIRCLE 430 ON READER SERVICE CARD

**Control Data's Stor- ageMaster** is a new line of disk memory products for the retail market. Initially it includes the model 409, a full-height, 5.25-inch flexible disk drive that stores up to 320K of data on a double-sided floppy diskette. Storage-Master drives will be stocked

and sold by Sears Business System Centers and participating ComputerLand stores. About \$430 to \$530, depending on retailer.

CONTROL DATA
CORPORATION
2200 Berkshire Lane N.
Minneapolis, MN 55441
612-553-4100
CIRCLE 431 ON READER SERVICE CARD

DT2818 from Data Translation is a new simultaneous sample and hold data acquisition system for the PC. It provides simultaneous analog input and analog output capabilities, as well as digital I/O and clock functions. The DT2818 combines the utility of multichannel signal freezing with the flexibility and low cost of personal computer controlled data acquisition. Included with it are two 12-bit digital to analog converters, which can be operated simultaneously or changed independently, depending on user requirements. \$1585.

DATA TRANSLATION
100 Locke Dr.
Marlboro, MA 01752
617-481-3700
CIRCLE 432 ON READER SERVICE CARD

#### SOFTWARE

Sorcim Corp. introduces SuperCalc<sup>3</sup>, an advanced

electronic spreadsheet featuring fully integrated, presentation-quality graphics and data management. The initial release of SuperCalc³ is for the IBM PC, PC XT, Compaq, and Eagle computers. It requires a minimum 96k of user memory under MS-DOS 1.0, 1.1, or 2.0. Upgrades from SuperCalc to SuperCalc³;—\$225; from SuperCalc² to SuperCalc² - \$125.

SORCIM CORP.
2310 Lundy Avenue
San Jose, CA 95131
408-942-1727
CIRCLE 433 ON READER SERVICE CARD

From **TICOM Systems** comes **TICOM TOOLS**, a new series of high-performance development utilities for the programmer. The first volume in the series, Input/Output Utilities, is available now and is for PC-DOS and MS-DOS. \$195.

TICOM SYSTEMS 13470 Washington Blvd. Marina del Rey, CA 90291 213-827-7118 CIRCLE 434 ON READER SERVICE CARD

**GMS Systems, Inc.** has introduced a new database management system for the IBM PC and XT. **Power-base** comes with a comprehensive user's manual and a 123-page tutorial for the beginning computer user. \$395.

GMS SYSTEMS, INC. 12 W. 37th Street New York, NY 10018 212-947-3590 CIRCLE 435 ON READER SERVICE CARD

Micro Focus has announced that four of its software products-LEVEL II COBOL®, ANIMATOR®, FORMS-2®, and the 8086-88 Native Code Generator (sold with High-Performance LEVEL II COBOL only) - are now available for the recently introduced IBM 3270-PC; the products are being distributed by Digital Research. LEVEL II CO-BOL-\$1,600. High-performance LEVEL II COBOL-\$2,000. FORMS II - \$200. ANIMATOR-\$800. MICRO FOCUS, INC.

MICRO FOCUS, INC. 1601 Civic Center Drive Santa Cara, CA 95050 408-496-0176 CIRCLE 436 ON READER SERVICE CARD

DIGITAL RESEARCH COMPUTERS OF TEXAS

P.O. Box 401565 Garland, TX 75040 214-271-3538

CIRCLE 437 ON READER SERVICE CARD

CodeWriter, from Dynatech MicroSoftware, Inc., allows a user to type his instructions onto the screen using normal English; the software translates the instructions into code.

PC TECH JOURNAL



The CodeWriter package includes a tutorial disk. \$249—IBM PC version.

DYNATECH MICRO-SOFTWARE, INC. 7847 N. Caldwell Avenue Niles, IL 60648 800-621-4109 312-470-0700 (in Illinois) CIRCLE 438 ON READER SERVICE CARD

FILELYNX/3278, a new software package from Local Data, interfaces an IBM PC to IBM mainframes, providing fully automatic file transfer and 3278 emulation at up to 9600 baud. The software requires Local Data protocol converters and a minimum of one serial card, 64k of memory, and any version of PC-DOS. \$200.

LOCAL DATA
2701 Toledo Street
Suite 706
Torrance, CA 90503
213-320-7126
CIRCLE 439 ON READER SERVICE CARD

SoftHelp, Inc. has announced HELP! Condor and Condor MENU, enhancements to the database by Condor Computer Corp. HELP! Condor—\$75. Condor MENU—\$125.

SOFTHELP, INC. 4237
Cole Avenue
Suite 111
Dallas, TX 75205
214-559-3095
CIRCLE 440 ON READER SERVICE CARD

A new drafting and design software package will be available soon from **United Networking Systems**, **Inc.** The package, called **Draft-Aide**, has five user levels ranging from a starter program to full professional applications for major engineering firms. Prices range from \$100 for the starter kit to \$55,000 for the complete system, which includes two IBM PC XTs, a H-P plotter, and Safford enhancements.

UNITED NETWORKING SYSTEMS, INC. 7007 Gulf Freeway Suite 108 Houston, Texas 77087 713-644-2427 CIRCLE 441 ON READER SERVICE CARD



INACOM International has developed a new information database for the design engineering department. Tech-Doc2® and the accompanying MICRO-INDEX® provide information on some 400,000 products; the information is updated every sixty days.

\$150 to \$10,000 depending on the number of product groups requested.

INACOM
INTERNATIONAL
4380 South Syracuse Street
Denver, CO 80237
800-443-INFO
CIRCLE 442 ON READER SERVICE CARD

The price of **Davong Systems**, **Inc.'s Multi-OS® tape backup system**, which safeguards data from any Winchester disk or floppy drive used with IBM PC or XT microcomputers, has been reduced to between \$1,795 and \$1,995.

INC.
217 Humboldt Court
Sunnyvale, CA 94086
408-734-4900
CIRCLE 443 ON READER SERVICE CARD

DAVONG SYSTEMS,

Call Manager Inc. has released MANAGER, a menu-driven application generator/database management program that runs on the IBM PC, IBM XT, and equivalent machines. MANAGER has three primary functions to create and store vital information; to manipulate data; and to retrieve and format data for posting, reporting, etc. \$195.

CALL MANAGER INC. 1961 Old Middlefield Way Mountain View, CA 94043 415-964-5333 CIRCLE 444 ON READER SERVICE CARD Volition Systems'
Modula-2 will be the first software offering from Springer-Verlag, the international publisher of scientific, technical, and medical books and journals. Modula-2, a language created by Niklaus Wirth (who invented Pascal) to overcome deficiencies of Pascal, uses modules to facilitate development and maintenance of large, complex software systems. \$595.

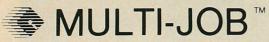
VOLITION SYSTEMS
P.O. Box 1236
Del Mar, CA 92014
619-481-2286
CIRCLE 445 ON READER SERVICE CARD

New software connecting IBM PCs to Honeywell mainframes has been announced by **Cambridge Computer Corp. PC77/78** allows the IBM PC to emulate the Honeywell VIP7700 and VIP7800 series of synchronous terminals, PC72/73 allows it to emulate the VIP7200 and VIP7300 series of asynchronous terminals. \$795 for PC77/78, \$395 for PC72/73.

CAMBRIDGE
COMPUTER CORP.
151 Bender Road
Mount Carmel, CT 06518
203-288-6004
CIRCLE 446 ON READER SERVICE CARD



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- No special hardware (except memory) required.
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- Up to 9 separate jobs.
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- Free 30-day trial period.

MULTI-JOB is available for \$159 from:



#### **B&L Computer Consultants**

7337 Northview, Suite B Boise, ID 83704 (208) 377-8088





MTM is currently available for certain terminals for \$59. Free brochure listing other B&L Products available upon request.

CIRCLE NO. 155 ON READER SERVICE CARD

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- Lightning Spike Damage
- Disruptive Line Noise
- Program Errors

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KLR-250A-1S0 250 Watt Load; Patented
Filter Isolated Sockets \$346.95
KLR-500A 500 Watt Load \$390.95
KLR-500A-1S0 500 Watt Load; Patented
Filter Isolated Sockets \$445.95

Shipping: \$12.75 Land; \$45.50 Air

Ask Your Local Dealer

#### Electronic Specialists, Inc.

171 South Main Street, Box 389, Natick, Massachusetts 01760

Toll Free Order Desk 1-800-225-4876 MasterCard, VISA, American Express

CIRCLE NO. 238 ON READER SERVICE CARD

#### OPT-TECH SORT™

### SORT/MERGE program for IBM-PC & XT Features

- Written in assembly language for high performance Example: 4,000 records of 128 bytes sorted to give key & pointer file in 30 seconds. COMPARE!
- Sort ascending or descending on up to nine fields
- Ten input files may be sorted or merged at one time
- · Handles variable and fixed length records
- Supports all common data types
- Filesize limited only by your disk space
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#### **PASCAL NEWS**

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PASCAL NEWS
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#### **TECH MART**







# TECH CALENDAR

#### **JANUARY**

January 31-February 3
Sixth Annual
Communication Networks
Conference and Exposition
for the Telecommunications
Business Professional
Washington, DC

Contact: CN '84, Box 880, Framington, MA 01701, 617-879-0700

#### **FEBRUARY**

February 14-16

#### ACM Annual Computer Science Conference Philadelphia, PA

Sponsor: CM

Contact: Frank L. Friedman, Dept. of Computing and Information Science, Temple University, Computing Center Bldg. 303, Philadelphia, PA 19122, 215-787-1912

February 20-22

Office Automation

Conference Los Angeles, CA

Sponsor: American Federation of Information Processing Societies Contact: AFIPS, 1815 N. Lynn St., Arlington, VA 22209, 703-558-3617

February 21-23

Softcon: The International Conference and Tradefair for the Software Industry New Orleans, LA

Contact: Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, 617-739-1000 or 800-841-7000

February 27-March 1

Compcon Spring '84: Intellectual Leverage—The Driving Technologies

#### San Francisco, CA

Contact: John Wakerly, Computer Systems Lab, Stanford University, Stanford, CA 94305, 415-856-0169

#### MARCH

March 12-15

Interface '84 Las Vegas, NV

Sponsor: Business Week and Data Communications Contact: The Interface Group, Inc., 300 First Ave., Needham, MA 02194

March 23-25

West Coast Computer Faire San Francisco, CA

Sponsor: Computer Faire Inc. Contact: 570 Price Ave., Redwood City, CA 94063, 415-364-4294

March 26-28

7th Intl. Conference on Software Engineering Orlando, FL

Sponsors: ACM SIGSOFT, IEEE, Natl. Bureau of Standards Contact: Robert Fritz, Telesoft, 10639 Roselle St., San Diego, CA 92121, 714-457-2700

#### APRIL

April 5-7

COMDEX/Winter '84 Los Angeles, CA

Contact: The Interface Group, 300 First Ave., Needham, MA 02194

April 9-12

TEEE Infocom 84 San Francisco, CA

Sponsors: IEEE-CS, IEEE
Communications Society
Contact: Judy Estrin, Bridge
Communications, 10401 Bubb Road,
Cupertino, CA 95014, 408-446-2981

April 17-19

Federal DP EXPO Washington, D.C.

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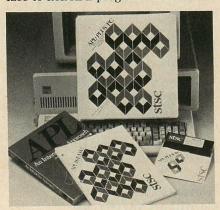
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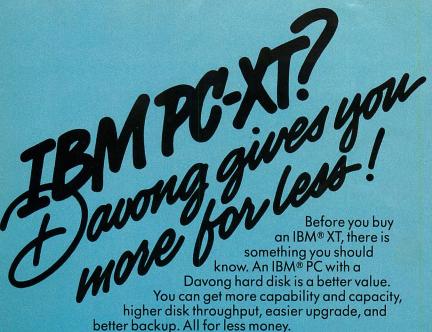
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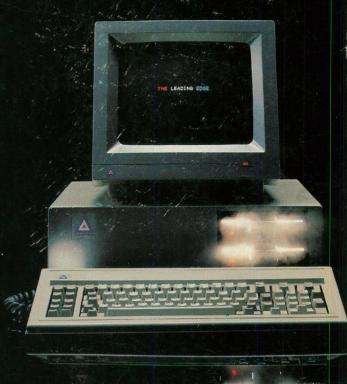
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